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A SUMMER AFTERNOON BY THE SEA.

THE TOMOPTERIS.

BY PHILIP HENRY GOSSE, F.R.S.

DURING the summer months a naturalist on any part of the coast may have many opportunities of obtaining some of the rarer marine animals, and among them not a few of highly curious structure, or otherwise possessed of great interest, by collecting at the surface of the calm sea. Influences, which we can at present only conjecturally estimate, or which are altogether inappreciable to us, bring, at certain times and in certain conditions, perhaps electrical, of the sea or of the air above it, many forms of delicate animal life from the recesses in which they ordinarily conceal themselves to that stratum of the water which is in close proximity to the atmosphere. On a quiet day, when the surface has a glittering mirror-like smoothness, when the sun is shining, but a hazy veil slightly mitigates the fierceness of his heat, in the afternoon hours, if the observer will take a boat and pull gently about under the headlands, and into the tiny bays and inlets that are separated from each other by points of black rock, from which long draperies of wrack and oarweed and tangle hang down in the sleeping water, he may take many a curious form which, under a lens or on the stage of his microscope, will afford him both entertainment and instruction. The eye is not of much service in this mode of collecting; many of the desiderata are of minute or even microscopic dimensions, and most of the others are so transparent and colourless, that even when culled from the teeming bosom of the waters, and inclosed in a clear glass vase, they can be discerned by the eye only fitfully and with difficulty. A bag of fine muslin stretched on a hoop of wire fastened to the end of a staff some five feet long, is the best appliance for securing the prey. There should also be in the boat a large glass vessel—a confectioner's cylinder is very suitable—and two or three phials, such as those in which chemists keep sulphate of quinine. If the collector add a couple of glass tubes, respect-

ively an eighth and a quarter of an inch in diameter, he will be set up.

As the boat is gently paddled along, making as little disturbance with the oars as possible, the operator standing in the bow, for the purpose of taking the water before the surface is broken, holds the bag so that the hoop shall cut the surface. After a few minutes he removes it from the water, and, turning it inside out within the large vase, allows the collected prey to float off into the vessel. Then raising this on his left hand to the level of his eye, he peers through the clear fluid, seeking to catch some movement other than that of the currents, or some flash of light from a reflecting body. The transparency of the water will most likely be dimmed, and his power of examination impeded, by a multitude of delicate filmy objects which he will in an instant see to be organic, but which, if he is a tyro, he will have difficulty in making out. These are the sloughs of Barnacles (*Balani*), the active creatures that inhabit strong conical fortresses of stone studding the rocks, and that ever thrust out and draw in a hand of many slender fingers, flexible-jointed, and fringed with an exquisite array of bristles. From time to time, the skin of this many-fingered hand is thrown off; and, as it remains entire, and every bristle is perfectly represented in the *exuviæ*, it is a very interesting object to examine, and to mount on a microscopic slide. These sloughs float by millions, and the collector having once satisfied his curiosity about them, will probably wish them somewhat less numerous or somewhat less obtrusive. However, he will soon learn to neglect them, and pursue his investigation in spite of their presence.

Perchance he detects a tiny bell of pure translucency, with a little clapper depending from its arch, and a series of strings of excessive tenacity attached to its margin. It shoots to and fro so rapidly, that he can scarcely keep it in sight; at length it takes an instant's respite, and he brings his dipping tube to bear on it, thus:—Before he inserts it, he claps his fore-finger tightly on the upper end, then plunging the other end into the vessel he brings it pretty close to the little bell he wishes to capture; then, for the briefest possible moment, he lifts his finger, the water rushes in at the lower end, carrying the prey with it; the finger is tightly clapped on again, and the contents of the tube are safely transferred to one of the smaller phials, isolated in pure water, and ready to be examined at leisure. He has caught one of the lovely little Naked-eyed Medusæ, a creature of exquisite grace and beauty.

I have some reason to think that in the darkness of the night more of such beautiful forms of life sport at the surface of the sea than even during the most auspicious day. The towing-net

which, in the smooth seas of the tropics, the naturalist-voyager rigs out over the quarter of the ship, and leaves to gather what it may, rarely fails to yield to the morning's examination, as the result of the night's collection, a variety of creatures which are rarely or never seen by day. And I have occasionally been amply rewarded by taking my muslin bag-net down to the sea-side at nine or ten o'clock at night, and dipping at random as I stood on the lowest step of the quay stairs, or on some projecting rock, while the water flashed with bright phosphoric radiance at every movement.

Occasionally too, by carefully searching over the tiny basins in the rocks left full by the retired tide,—those most fascinating little pools which are fringed all round with floating filmy leaves of green or crimson, and tiny flexible shrubs with purple branches as fine as hair,—we may succeed in taking a prize. It was thus that a scientific friend a day or two ago obtained a very rare and otherwise interesting animal, which he kindly put into my hands.*

It was *Tomopteris onisciformis*. Ten years ago, when I was spending a summer at Ilfracombe, I met with it, in the way I have described above, dipping it with a muslin net from the open sea. Believing it to be new, I described and figured it under the name of *Johnstonella Catharina*.†

In this supposition I was mistaken; and soon afterwards Dr. John Edward Gray, of the British Museum, gave the following information concerning the animal, in a note in the *Annals and Mag. of Nat. Hist.* for August, 1853:—

"It appears to belong to the same genus as the animal described by Eschscholtz in the *Isis* (1825), p. 736, t. 5, f. 5, under the name of *Tomopteris onisciformis*, from the South Seas; and by MM. Quoy and Gaimard, in the *Voyage of the Astrolabe*, ii. p. 284, t. 21, f. 21, 24, under the name of *Briarœa scolopendra*, from the coast of Spain. Hermannsen has proposed to change the latter name to *Briarœa;* Harry Goodsir calls it *Briareus;* and Mr. R. Ball writes it *Bryarea*.‡ Eschscholtz, and Quoy and Gaimard regard it as a mollusk; the first referring it to the order *Heteropoda*, and the latter to the *Nudibranchiata*.

"Mr. Harry Goodsir, who found the animal abundant in the North Sea (*Ann. and Mag. Nat. Hist.* 1845, xvi. 163), observing the presence of 'cilia fringing the bifurcated poste-

* I call it rare, because through ten years' habitual searching of the sea on our south and south-west coasts, I have met with it so seldom. Dr. Carpenter however, finds it not uncommon on the western shores of Scotland.

† *Devonshire Coast*, p. 356, pl. xxv.

‡ Probably in ignorance of the allusion, which was to Briareus, the hundred handed giant of the old Greek theogony. If the name had been retainable, Mr. Goodsir's orthography would have been the more correct one—Βριάρεως.

riors of the lateral extremity of its body,' decided that it could not be a mollusk.

"Menke (*Zeitsch. für Malac.* 1844, 21) proposes to remove the genus to the Annelides; more recent authors have considered it as a Crustacean.

"Mr. Gosse at first sight thought it might be a Brachiopod crustacean, but thinks it has more affinity to the Annelides (p. 348), and refers it to that class in the Systematic Index.

"According to Eschscholtz, and Quoy and Gaimard, the South Sea specimens are very much smaller than those found in the Mediterranean; thus, *Tomopteris onisciformis* and *T. Scolopendra* are most probably distinct species. Mr. Gosse's *Johnstonella Catharina* is, no doubt, a synonym of the latter, since Mr. R. Ball records that *Bryarea scolopendra* has been taken in Dublin Bay by Dr. Corrigan." (*Proc. Brit. Assoc.* 1849, p. 72.)"

In addition I should state that Dr. Adolph Edouard Grube, in his excellent work *Die Familien der Anneliden* (Berlin, 1851), has included the genus, without question, among the Annelida; constituting a family and an order of it alone, which, with the curious caterpillar-like *Peripatus*, of the West Indies, of which he makes another order, he intercalates between the *Terebellacea*, and the *Lumbricina*. Dr. Grube includes but one species in the genus, quoting Quoy and Gaimard's *Briareus scolopendra* as a synonym of Eschscholtz's *T. onisciformis*.

The following is Grube's account of the family, with its technical characters :—*

"ANNELIDA.

"Ord. *Gymnocopa*. Fam. *Tomopteridea*.

"Body lengthened or worm-shaped, slender, with broad floats, often small or not well developed towards the hinder end. Segments not very numerous, not separated by bounding furrows.

"Head-lappets united behind with the mouth-segment; the former with short antennæ, the latter (hinder) with very long tentacular cirri, in which, as in the antennæ, a bristle-like part is set. Two eyes.

"Mouth directed downwards, unarmed, proboscis not observed.

"Lateral processes of the segments forming considerable floats, two-lapped, without bristles or needles.

"We know as yet but one genus, *Tomopteris*, with a single species, of which the external and internal structure has been thoroughly investigated by Busch. The body is amazingly

* Op. cit. p. 95.

transparent; the alimentary canal straight, without enlargements, vessels not perceptible; the blood colourless; the sexes separate; the eggs lie free in the abdominal cavity. The nature of certain rosette-shaped organs, found within at the base of the floats, Busch could not ascertain. The nervous cord in living specimens is difficult to detect, but in animals preserved in spirits I found its halves laid close side by side, scarcely forming ganglionic swellings, and the mouth ring narrow.

"Genus *Tomopteris*, Esch.—*T. onisciformis*, Eschsch. *Isis*, 1825, p. 736, tab. v. fig. 5. Busch, *Müll. Arch.* 1847, p. 180, tab. vii. fig. 5. Grube, *Idem*, 1848, p. 456, tab. xvi. figs. 9—13. *Briareus scolopendra*, Quoy et Gaim. *Ann. des Sci. Nat.* x. p. 235, tab. vii. fig. 1."

As the creature under notice is not only one of great rarity, but also of more than usual elegance, I have thought that a figure drawn from the present specimen, and a description of its principal features, might prove not uninteresting to that large portion of the readers of the Intellectual Observer who are at this season rifling the treasures of the sea among the secluded coves and smiling tide-pools of our rocky shores.

Fig. 1 in Frontispiece represents a male *Tomopteris onisciformis* when first taken, magnified six times; its natural dimensions during the vigour of health extending to about an inch and a half in length. Strange to say, it rapidly deteriorated in confinement; though transferred within an hour of its capture to a tumbler full of sea-water, it steadily diminished till, in the course of about four hours, it was not more than three-quarters of an inch long; and this, not by a contraction in length only, but by an uniform diminution of all its parts, so that the same form and proportions were maintained, but on a constantly lessening scale. Nor was this the only alteration perceptible; when my friend, a gentleman of science accustomed to accurate observation, captured it, the animal was so perfectly diaphanous that, when searching the pool, with his eye brought as close as possible to the surface, he caught sight of it only by the flashings and twinklings of light reflected from the rapidly-moving fins of its side-processes; and when he caught it by placing his hollowed hands, basin-wise, under the twinkling spot, and lifting out the water, he could see nothing of it either in his hands or in the bottle into which he poured the contents. So thoroughly was it transparent, and so exactly was the refrangibility of its body-tissues that of the circumambient water, that when he put the cork into the phial, and examined it, he actually could not discern the creature, and supposed that he had either failed to capture it, or else had lost it in pouring the water from his hands. Yet when, an hour afterwards, he brought it to me, the animal was distinctly visible, and could

not be lost sight of, though still brilliantly transparent. And in the course of the three or four hours occupied in my observations, it became less and less hyaline, increasing in opacity as it decreased in size; till at length, when I put it into spirit for preservation, some five hours after capture, it was quite opaquely white, and scarcely above half an inch in length.

The body is slender, flattened, tapering to an attenuated tail of great length; much larger relatively in this individual than in my Ilfracombe specimens, the tail occupying nearly two-fifths of the entire length.* The lateral processes give an appearance of flatness to the body, greater than it really possesses; for when viewed sidewise, the trunk, independent of the fins, is about as deep as it is broad. The body is furnished with fifteen pairs of these lateral limbs (*a a*), which are manifestly analogous to the foot-processes in a *Nereis* or *Syllis*, but show no traces of the pencils of bristles so characteristic of the ordinary *Annelida*. Each foot divides at its tip into two thin expansions of delicate *sarcode* (transparent fleshy tissue), each of which assumes somewhat of a fan-shape, and is capable of being convoluted into an obliquely truncate cone. I could discern no appearance of external cilia. A transverse section of the foot-base would have an elliptical outline, whose longest diameter is vertical.†

These terminal expansions are used as fins, being waved in the water with great sprightliness and activity. They thus constitute a powerful locomotive apparatus, and may be instructively compared with the leaf-shaped swimming-fins attached to the upper surface of the feet in *Phyllodoce*.

The head is remarkable for its accessory organs.‡ These

* When this paper was written, I was not aware that the *Tomopteris* had been the subject of two valuable memoirs by Drs. Carpenter and Claparede, published in the *Linnean Transactions* for 1859 and 1860. Mr. Slack having very kindly sent me an abstract of the latter, I add in notes some particulars of structure which escaped my own observation.

These eminent naturalists find that the animal passes through a larval stage, which differs materially from the adult condition. They figure a larva, only ·04 inch in length, in which the tail is altogether wanting; there are but three pairs of fins, the antennæ, or first pair of head processes, *are much larger than in later life*, and the cirri, or second pair, show only a commenced development.

† Each of these processes, after the first five pairs, is furnished with two pairs of minute rosette-shaped organs, one pair placed near the base of the fin, the other on the terminal lobe-like expansions. The former are described as the external orifices of ciliated canals, which presently unite into one that runs along for some distance in the wall of the body, and then terminates in the body-cavity. These canals appear to admit the external sea-water to percolate into the cavity, which is then replenished with the products of digestion by exudation through the walls of the alimentary canal, and becomes a blood-like nutritive fluid.

‡ MM. Carpenter and Claparede describe on the dorsal surface of the head "a pair of ciliated epaulettes, which extend over the edges of the bilobed nervous ganglion. These, at a certain stage of development, are fringed with long cilia, both at their margin and at their base."

are two pairs, of which the anterior (*b*) may be considered antennæ, and the posterior (*c*) tentacular cirri; but these distinctions are perhaps somewhat arbitrary, and are rather convenient than precise. The antennæ (fig. 3) consist of a marginal portion, thick and cord-like, of granular tissue, of which the anterior is thicker than the posterior edge, and a thin clear membranous portion stretched across. The latter seems double, and to inclose a cavity filled with fluid; for I observed eddies of minute corpuscles, which were accelerated whenever they approached the cord-like margins.

The second pair, or cirri (*c*), have a similar structure, but the front cord is prolonged into a stiff straight seta of a length superior to that of the body and tail, which points obliquely backward, and is capable of but a very slight change of direction, by a contraction of the hinder part of its base. This pair is probably the seat of a delicate sense of touch.

Immediately between the bases of the cirri are seated the two eyes (*d*); each consisting of a distinct lens,* very convex, seated on a much larger mass of black pigment, and looking outward laterally, and the whole eye inclosed in, or resting on, a globose body of translucent tissue, probably a nervous ganglion, which is in contact with its fellow (see fig. 2). I did not remark any movement in the eyes.

Viewed from beneath, the cavity of the mouth is seen to open just under the eyes (*e*), the aperture being formed by an irregular corrugation of the surrounding flesh, forming lobes. In one of my Ilfracombe specimens, I was so fortunate as to see the protrusion of a thick œsophageal proboscis to some distance, of an ob-conic form, or somewhat trumpet-like, with a large four-sided orifice obliquely terminal. This observation was the more important, as such a protrusile œsophagus is eminently characteristic of the *Annelida*, and does not seem to have been seen in this animal by any other observer. In my recent specimen, the œsophagus (*f*), when withdrawn, reached to the second pair of fins, where, after a constriction, it expanded into an alimentary canal (*g*), having distinct corrugated walls, whose outline was commensurate with that of the body cavity, with a slight tendency to enter into the bases of each pair of fins. The cardiac extremity of this viscus, during my examination, was insensibly pushed forward, so as to inclose the termination of the œsophagus, but not changing the position or the appearance of the latter. It was manifestly empty.†

* MM. Carpenter and Claparede state (and quote the testimony of MM. Leuckhart and Pagenstecker to the same point), that the lens in each eye is double. It, however, appeared to me manifestly single.

† The alimentary canal in one specimen obtained by MM. Carpenter and Claparede contained fragments of a Beroe, which were kept in active motion by their own cilia.

The alimentary canal appeared to have a cloacal orifice, which, however, I did not distinctly define, between the fifteenth pair of fins (*h*), where I consider the tail to commence. This portion of the animal is nearly of the same diameter throughout, composed of nine segments, of which the bounding furrows *are* distinguishable, notwithstanding what Grube says to the contrary. The segments of the *trunk*, on the other hand, are only to be inferred. Each segment-furrow bears a pair of lateral processes. Of these, the earlier ones are not to be distinguished from the body-fins, which have been degenerating from about the middle pair backwards, except by still further degeneration; but as they approach the posterior extremity, they become more and more rudimentary, and can scarcely be discerned on the last one or two segments. The tail is perforated throughout by a viscus, which in most parts appeared simple, though with corrugated walls, but near the base was very manifestly composed of two cord-like portions, irregularly twisted together—a strange and unaccountable structure. The viscus inclosed at intervals two large oval air-bubbles, the effect of which, though accidental and unimportant, on the appearance of the animal, from the different refrangibility of the air, was very striking. More structurally interesting was the evidence of a circulatory fluid, surrounding and bathing both this viscus in the tail and the alimentary canal in the trunk; for at intervals there were seen groups of blood-corpuscles whirled to and fro and circling in irregular eddies, revealing the fact that the body-cavity is lined with a ciliated membrane. This fluid evidently bathed the whole interior of the body, and surrounded the alimentary canal, without the slightest trace of a dorsal vessel.

The walls of the body showed a texture composed of longitudinal fibres, very distinct.

Within the caudal cavity there was a series of organs of whose nature I am doubtful. At the points where the degenerated fin-processes originate on each side, there was a gland(?) shaped like a kidney-bean (*i*, and fig. 4), composed of pale brown granular matter, attached to the inner wall by a short stalk arising from the concavity, just as a bean is attached at the *hilum*. The texture and appearance of these bodies had so much resemblance to those of maturing ova (as in the *Rotifera*), that I should have concluded such to have been their solution, but for their isolated manner of attachment, and the absence of any viscus that I could identify with an ovary.*

* These glands are considered by MM. Carpenter and Claparede to be the *testes*; the form is probably inconstant, as they figure them of a very different shape. They found them filled with *spermatozoa*, which were furnished with *two* whip-like tails—"a common structure in the antherozoids of *algæ*, but rare, if not unique, among spermatozoa of animals."

The ova in the female are lodged in the general cavity of the body and tail.

Though to the unassisted eye the whole animal appeared to be destitute of colour, with the exception of the black eye-specks which are just discernible—the microscope shows that the skin is studded with minute scarlet dots, arranged somewhat sparsely in linear rows on the median line of the back, along the cirri, and irregularly scattered or grouped on the sides, fin-processes, and tail.

A few hours' captivity sufficed to deprive this delicate organism, before so agile and so vigorous, of motion and of life. It is strange that many of the low forms of animal life which swim freely in the open sea, are so excessively impatient of confinement, as to exhaust themselves even in what seems to be an ample supply of pure water. Many a tiny creature less than an inch in length, caught as it frolics in its abounding vivacity at the surface of the wide ocean, and transferred, without contact with anything firmer than its own pure element, to a bucket full of water, dies of utter exhaustion in a few hours. How and why is this? It cannot be that the oxygen has been all taken up in so brief a time. It is as if a man shut up beneath the dome of St. Paul's should be found dead by daylight for want of air to breathe. Are the gills of an Anneloid or a Mollusk more *exigeant* than the lungs of a man?

Explanation of the Illustration.—Fig. 1.—*Tomopteris onisciformis* magnified six diameters. *a*, the fins, or lateral processes; *b*, antennæ; *c*, tentacular cirri; *d*, eyes; *e*, aperture of mouth (in fig. 2); *f*, œsophagus; *g*, alimentary canal; *h*, cloaca (?); *i*, tail-processes, and contiguous glands. Fig. 2.—Inferior surface of the head, more highly magnified; showing the insertion of the lens of the eye in the pigment mass; and the aperture of the mouth (*e*). Fig. 3.—Antenna highly magnified. Fig. 4.—One of the joints of the tail, with the rudimentary fins, and the reniform glands.

PHOTOGRAPHIC DELINEATION OF MICROSCOPIC OBJECTS.

BY GEORGE S. BRADY, M.R.C.S.

To be able to produce with rapidity and faithfulness representations of such objects and phenomena as are visible in the field of the microscope, is a matter of great importance to the labourer in almost every branch of natural science. Some observers are content to discard all adventitious aid, and to draw from the microscope in the same way as they would from an unmagnified object, relying for success on their own skill as draughtsmen. But though this method when well practised gives results, perhaps more spirited and life-like—more artistic in short—than any mere camera drawing can do; it is evident that the skill required is greater than can be brought to bear by the greater number of microscopists, and, moreover, in the best case it offers no unquestionable guarantee of faithfulness. To obviate these difficulties, to lighten the labour on the one hand, and to ensure perfect accuracy, at least of outline, on the other, the instruments in common use are the camera lucida of Wollaston and the steel disc of Sömmering. These are adapted to the eye-piece of the microscope, and by throwing the image down on to the table, so that its outline may be easily traced on a sheet of paper, they offer very great advantages. But even with these appliances, when the object to be drawn is very elaborate in its details, the labour involved is great, and in the case of living organisms their movements are a source of great perplexity, as an unlucky twitch of a limb may in a moment render useless the work perhaps of hours. Photography of course very early suggested itself as the remedy for all these hindrances, and a very encouraging amount of success attended the first attempts which were made in this direction. Mr. Shadbolt, many years ago, published in the *Microscopical Society's Journal* one or two very good photographs of microscopic objects, with an account of the process which he adopted, but it does not appear that any great practical results have followed so auspicious a beginning. For a long time, indeed, the cumbrousness of photographic appliances was a sufficient bar to any general use of them. In the midst of microscopic investigation, to have to busy oneself with preparing sensitive plates, and going through the whole processes of exposure, development, and fixing, was more than could be tolerated; but now that iodized plates can be kept always ready for use, and after exposure may be left any length of time for development, there is very little to be urged as to the *unhandiness* of the process, which is indeed exceedingly simple.

The body of the microscope being brought to the horizontal position must be inserted into the front of an ordinary portrait camera, from which the lens has been previously removed. In the absence of a special adapter, the aperture round the tube must be stuffed with some convenient material so as to exclude light. The image of the object is then to be accurately focussed on the ground-glass by means of the ordinary coarse and fine adjustment-screws of the microscope.* After focussing, however, it will be found necessary to make a trifling alteration in the adjustment, for the object-glasses being made with an "over-correction," in order to compensate for the "under-correction" of the eye-piece, their visual and chemical foci do not correspond; and thus the actinic rays are brought to a focus slightly beyond the visual rays. On this account the object-glass will need a certain amount of depression varying with the power, and the higher the power the less alteration will be required; usually with a quarter of an inch objective the chemical and optical foci are so nearly coincident that the difference may be overlooked in practice. The amount of depression required for each lens can only be ascertained by repeated experiment, but the following data which apply to my own object-glasses (Powell and Lealand's) may be taken as an approximation. The one inch glass requires a depression amounting to one turn and a half of the fine adjustment screw (about one seventy-fifth of an inch.) The half inch requires about half a turn of the same screw.

The most satisfactory illumination is a strong sunlight reflected directly upon the object by the concave mirror. Light reflected from a white cloud opposite the sun, will indeed answer the purpose, but the time of exposure is necessarily greatly increased, and the impression when obtained is much inferior in point of brilliancy and distinctness.

The "collodion" process is doubtless the best that can be used for microscopic purposes. Indeed, if the direct sunbeam be employed as the illuminating agent, no good result can be obtained with a less sensitive material, for the situation of the image on the prepared plate is continually altering with the altering position of the sun. The time of exposure must differ considerably according to the intensity of the illumination, the medium in which the object is mounted, and the nature of the object itself. When using the direct rays of the sun I have generally found from fifteen to forty-five seconds sufficient for a collodion negative.

Recent discoveries, by means of which sensitive plates may

* It is not the aim of this paper to explain the details of ordinary photographic manipulation. For information on these points, the reader must consult some one of the numerous manuals of photography.

be constantly kept ready for use, have, as previously stated, removed one great impediment to the prosecution of microscopic photography. The point to which attention should now be directed, is the attainment of some simple method of artificial illumination. The illuminating agents now in common use are all greatly deficient in actinic power; and though photographs have been taken by their light, they are practically unavailable. It is evidently impossible that this application of photography should become at all general so long as it is entirely dependent on a brilliant sunlight, or on such agents as the electric and oxyhydrogen light, but if some easily produced flame, rich in actinic rays, could be devised, then we might reasonably look for a very extensive development of this branch of the art. It could then be practised in all weathers, and at all hours, and there are few objects which could not be represented successfully by its means.

ZOOLOGY OF THE INTERNATIONAL EXHIBITION.

Though there are very few contributions to the International Exhibition that directly claim the attention of the zoologist, those that illustrate the great subject of economic zoology are literally numberless, and to classify or analyse them in detail is both impossible and unnecessary. The British colonies present the best examples of complete exhibition, they show us the animals and their products side by side; elsewhere we see products only, except in certain special exhibitions in the English and French departments of a strictly zoological kind, and having little or no relation to economics. As we traverse the nave we catch a sight of skins, furs, fleeces, here and there stuffed specimens of birds and mammals, but the forms are those we are mostly familiar with, and it is only when we have sought out and examined the objects we had marked for inspection in the catalogue, that we can take a leisurely view of lions, tigers, parrots, macaws, and reindeer, which are generally placed as a sort of sign-posts to guide and attract visitors to manufacturers' collections of materials and furniture. Still there is as much for the zoologist as he would expect in an exhibition which has for its main idea to illustrate the progress of handicrafts and the mutual commercial relationships of the nations, for of necessity many of the most important industries carry us direct to the ocean, the pasture, the wilderness, and the jungle, and invite us to consider the ways of Nature in fashioning her creatures so that life and happiness may go together, and the combination subserve the purposes of man. The converse might be said,

perhaps, if we were to indulge in some severe philosophy, and the spirit of Pope's lines on the mutual relations of man and goose, would have a new illustration. But dealing with the practical, and, following as nearly as possible the order of the catalogue, it will be seen that the United Kingdom exhibits products only, and though these are of a common-place character, they offer points for the consideration of the scientific visitor neither unimportant nor uninteresting.

Traversing the Tasmanian Courts, we find interesting exhibitions of the products of the whale fishery, which has become so important a branch of the industry of that colony. The Commissmissioners' collections (194—330), and those from W. Powel (560—566), and M. Sanderson (579—580), show that the sperm whale still abounds in the Southern Ocean. The jaws of the sperm whale forming the apex of the trophy will indicate that fish of immense size are captured. The whales furnishing the two great jaws produced respectively oil and head-matter worth £1150 and £900. *Balæna marginata, Australis,* and *Antarctica,* the Australian, New Zealand, and Cape whales; *Catodon polycyphus,* the South Sea sperm whale, and one or two species of *Delphinidæ,* afford the sport and profit of the southern fisheries, which the Tasmanians have developed with so much spirit, and which attract American vessels to share the risks and rewards of the chace. There are now twenty-five whaling vessels attached to the port of Hobart Town, and these employ a fleet of 131 boats, two of which are suspended from the Tasmanian trophy. Last year the exports of oil and head-matter amounted to £60,350. New Zealand does not illustrate its position in regard to the whale fishery, but Queensland calls attention to another of the *Cetacea* in the exhibitions of dugong oil (22, 24). This is obtained from *Halicone dugong,* one of the herbivorous whales, and the most interesting, zoologically, of any of the series exhibited, so that we wish a complete skeleton had been forwarded for addition hereafter to some of our museums. This fish is found in great herds at the mouth of the Brisbane, and is easily captured. The flesh would probably prove to be as good for food as that of the porpoise (*Phocœna communis*), which, from the time of Henry VIII. to that of Queen Elizabeth, was considered a royal dish. Certainly the oil is likely to acquire as much fame for its curative properties as that from the liver of the cod, and the Tasmanians have but to make its merits known to secure good markets, and the extension of the fishery. From the *Cetacea* to the *Phocidæ* is but a short zoological step, and in the Tasmanian Court are specimens of elephant sealskin. (461.) *Macrorhinus proboscideus,* which the visitor will notice as capable of many useful applications in the arts. This is the far-famed sea-elephant of the Atlantic and Southern Oceans, which owes

its name as much to its enormous size as to the possession, by the male, of a proboscis. An adult specimen of this species measures about twenty-five feet in length. Compare this specimen of seal leather, like rhinoceros hide, with another in the Denmark Court, where J. W. Taylor, of Greenland, has a most interesting collection (No. 183). These examples appear to be the produce of the harp-seal, *Calocephalus Greenlandicus*, which has less wool than other species, and the hair of the leather flat and lustrous. Amongst the specimens is the skin of a seal fœtus, which may remind the vistor that in certain remote parts of Her Majesty's home empire, cows are killed just before their time of calving, for the sake of the skins of the fœtuses for first class gloves.

Horns appear in a thousand different shapes. In the Indian department Messrs. Halliday and Fox (130) show buffalo horns worthy the attention of students of the genus *Bos*, for the Arnee is represented with others less rare. Natal (2) presents us with samples of horns of the *Cervidæ* of South Africa. New Brunswick (31) sends a pair of moose horns of gigantic dimensions. Let none who take interest in horns miss an inspection of the horn furniture in the Austrian department, class 30, from H. Kietel of Vienna (1206).

Visitors bent on natural history studies, will have to consider the contributions of classes 4 and 25 together. In the first are wools, in the second skins, fur, feathers, and hair. The sub-class B contains a grand collection of wools from the Royal Agricultural Society of England (1007). The Austrian fleeces are equally interesting, but the French merinos surpass in beauty all the many contributions in this section, and whoever has the patience to search them out—scattered as they are through many provinces—will be able to read the history of the merino and the hitherto ineffectual efforts to mould its gaunt outlines to models adapted for meat production. Classify all the wools, and the result will be that climate is the main element in determining their character. Low temperatures favour the growth of shaggy wools and abundant grease: high temperatures produce silky fleeces almost free from grease, and merge the sheep and goat into such approximative forms that at last it is hard to distinguish them.

The English furs comprise gatherings from every climate of the world. From the tropics, lions and tigers; from arctic wilds, white and blue foxes; from Siberia, sables. The South Sea sealskins, shown by Mr. Lillicrapp (4505), took three years to collect in the Falkland Islands. Generally, sealskins are scarce, beavers more scarce; the first is following the second in the process of extermination. Among the colonies New Zealand shows but a poor fauna, but the Australian settlements exhibit

proofs of possessing a wealth of animal life, to which none of the European or American communities can offer anything like a parallel. Here, in various forms, we have products of the kangaroo, opossum, platypus, flying opossum, black cat, tiger cat, and immense collections of birds, mostly of gay plumage. In 1872 the Australians may send specimens of home-bred blackbirds, thrushes, sparrows, and starlings; these are all naturalized, and are increasing wonderfully, to the benefit of the agricultural interest. The case of grey and black opossum furs in the Tasmanian Court, is one of the most beautiful of the contributions from the Australians.

Notwithstanding some of the main features of the disastrous journey of O'Hara Burke into the interior of Australia, the camel is so far a successful introduction that the means of exploration are added to by its whole value for traversing vast regions of desert destitute of both herbage and water. There is not a single contribution of any kind from either of the provinces to illustrate this new item of Australian wealth and power, but we may name, in passing, a very interesting collection of objects from the interior, collected by J. M. Stuart, and exhibited in the South Australian department, under the north-east transept, by Mr. J. Chambers (77). The fitness of the more tropical parts of that continent for the camel is prefigured in the success which has attended the introduction of the Lama, Alpaca, and Vicuna. New South Wales, the parent colony of the group, leads the way in an enterprise which is likely to change the whole character of the pastoral districts by the substitution of alpacas for sheep. At the back of the Court is a case containing seven stuffed specimens—lama, alpaca, and five crosses between them. The crosses show several intermediate stages between the bare head and woolly covering of the lama, and the covered head and fine, long, hairy wool of the alpaca. The Commissioners exhibit articles manufactured from alpaca wool (24), and J. Nott (169) shows alpaca tallow and pomade. As an experiment in what is termed "acclimatization," the introduction of the alpaca to Australia must take first rank. The task was undertaken by "an enterprising gentleman named Ledger," and it occupied him during a period of four years to get the flock safely landed. He first visted Australia to ascertain if the climate and native herbage were suitable. He then returned to Peru and collected a flock, but the prohibition of the government against the exportation of the animals rendered it impossible to ship them from a Peruvian port. He commenced the arduous task of conveying them to Chili overland, crossed the Andes slowly but safely with his contraband treasures, and, after innumerable dangers and difficulties, got them to Copiapo, whence they were safely transmitted to Australia.

The flock of 276 was landed at Sydney in November 1858, and in spite of some deaths immediately on arrival, in the following month of April the flock numbered 284, consisting of 46 pure male alpacas, 38 pure female alpacas, 110 pure female lamas, 27 females cross between alpacas and lamas first generation, 11 females from male alpacas and females from first cross, 5 females from male alpacas and females from second cross; 40 lambs first, second, and third cross; 5 male vicunas, 1 female vicuna, 1 male gelded lama carrier. These animals have thriven beyond expectation, and the various crosses, and the right kinds of crosses, promise to become subjects as fruitful of discussion as those relating to the various breeds of sheep. The colony of Victoria obtained alpacas by a quite different process. A person named Gee speculated in a flock which he took to New York, thence to Glasgow, Birmingham, and London. At London some of the animals were sold to Mr. Palliser, Miss Coutts, and Mr. G. Lloyd. Mr. Wilson, editor of the *Melbourne Argus*, bought the remaining thirty animals at £23 per head, and shipped them for Melbourne, where they have increased, multiplied, and are now rendering good profit to their owners. That lamas, alpacas, and vicunas should interbreed is neither new nor curious information, for the probabilities are many and strong that they are all varieties of one cameline type, differing from the camel chiefly in the structure of the foot, which in these is adapted for climbing, and in the absence in the lamas of two small false molars from each jaw. But the breeders of Melbourne and Sydney may work out an interesting zoological problem, and perhaps originate an additional source of national wealth, in ascertaining if the lama and the camel can be made to furnish mules, for it is just such an intermediate form as might be expected from the cross that is wanted for conveying the baggage of exploring parties in the interior.

Among miscellaneous contributions there are stuffed animals of all kinds and from all places. Generally, birds are well done. The British birds from G. B. Ashmead (Educational department), (5588), A. Bartlett (5589), and W. Short (5611), are admirable examples of what may be done for the introduction of natural history studies in schools and families. But the most interesting exhibition of this kind is in the French Court, where M. Florent Prevost exhibits specimens of all the small birds of France, accompanied with preparations of their stomachs and samples of the food they eat. This beautiful collection is accompanied with copies of a pamphlet for free distribution among visitors by the *Société d'Acclimatation*. The pamphlet is entitled *De la destruction du Hanneton* (Maybug) *et de son emploi pour la nourriture des jeunes oiseaux*. If birds are well done we cannot say the same for larger animals. The lions,

and tigers, and deer, are mostly stuffed according to museum models,—that is, the body is stretched out in the form of a regular cylinder, and the legs and head are in any position except such as would be seen in life, so that if restored to life in the form and proportions which result from the process of "stuffing," none of the deer would be able to graze, and no tiger or panther could scratch its ears with the claws of the hind foot, a favourite pastime with all the cat tribe when quite at ease. We must make honourable exception to the samples of stuffing shown in Messrs. Nicolay's collection, No. 4512, in the nave. By passing round to the rear of this stall, the visitor will see what is probably the finest example of truly scientific mounting ever accomplished. It is a group of a tiger and a serpent in combat, by J. Kiellick of Buttesland Street, Hoxton, and has been rewarded, as it deserved, with a medal. This is an anatomical study rendered romantically truthful by the spirited conception of the artist. Under the western dome will be seen one of the two royal Bengal tigers sent by Colonel Reid (398), the other we have not found, but it is probably close at hand. Though mentioned last, this is the grandest contribution of a strictly zoological kind in the whole of the Exhibition. In none of our museums have we a specimen so truthfully modelled as this. Here, indeed, is the expression, attitude, and proportions of life; this tiger can scratch its ears, or bound noiselessly through the jungle in pursuit of its terrified prey, or escape the hunter who has marked him for a prize. If the zoology of the Exhibition does not invite lengthened or elaborate comment, it is because man rather than Nature is the subject of its illustration, and if the zoologist finds but little to call for special remark, the ethnologist will be well rewarded, for it has served to bring together a greater diversity of living human forms than could have been hoped for had it been professedly an ethnological congress, and we trust the students of the races of mankind have availed themselves of the opportunities offered them to add to their stock of knowledge derived from observation.

XUM

THE INFLUENCE OF MASS ON THE PRODUCTION OF INFUSORIA.

BY HENRY JAMES SLACK, F.G.S.

In the account given of M. Pouchet's experiments on the production of infusoria, in the Intellectual Observer, vol. i. page 88, reference is made to his theory of the influence of the mass of fermenting matter on the character and number of the minute beings whose appearance is observed. If your readers will turn to the article alluded to ("Conditions of Infusorial Life,") they will find ample details of M. Pouchet's investigations, but it will be well to cite his exact words on the particular subject of these remarks. He says, "it is evident from this experiment (one mentioned in an article), and from many others which we have made of the same kind, that the organization and the number of animalcules became elevated in direct proportion to the mass of the body in a state of decomposition."

With a view to test this assertion, I took twelve test tubes an inch in diameter and about three inches long, arranged in two rows in a mahogany stand. By this means the extent of surface exposed to the atmosphere would equal that of a good sized vessel, and thus the chance of catching floating germs would be considerable, while from the small dimensions of each tube a fermentation of very limited extent could be conveniently carried on.

The tubes were charged all alike, with about six drams of distilled water, and exactly three grains of finely chopped new hay in each. The whole set was placed on the mantelpiece of my study, a room with a north aspect, and in which the summer temperature remains tolerably steady. The experiment was commenced on the 4th of July, and the tubes were examined on the 17th of the same month, the thermometer having indicated about 65° during the whole time. The hay had floated in each vessel, and thus was favourably situated for atmospheric influence, and in every case a mouldiness was noticeable. Number 1 contained minute vorticellæ, mostly without stalks, the body when expanded being about 1—400″. When contracted these little creatures were lemon-shaped, the short neck being like the nipple-shaped projection noticeable on that fruit. They were active and lively, showing alternate contractions and expansions, and strong ciliary motion. No. 2 had a number of minute pear-shaped animalcules, with conspicuous vacuoles at the thick end, and at the other a narrowish neck ending in a small expanded tube. I do not know exactly what they were, but their form was much like that of the *Spathidium hyalinum*, drawn in *Micrographic Dic-*

tionary excepting that their necks were narrower. No. 3 contained minute paramecia. No. 4 possessed creatures resembling urostyla, but less than one-fourth the proper size. They had also in front a conspicuous bunch of cilia. The pellicle contained multitudes of dead vibrions, minute and short, with a few of a longer shape.

At a later examination No. 2 contained a quantity of round and pear-shaped creatures about 1—500″ long, frequently changing their form, and being covered with fine cilia. No. 3 had small kolpods. No. 4 kolpods and paramecia. Nos. 5 and 6 kolpods exhibiting numerous minute cells all full of granules. The remaining tubes were similar to the preceding, except one that contained many small rotifers (vulgaris) which preserved their small dimensions for some weeks.

In these cases the quantity of hay was much less than in M. Pouchet's experiments, but in every instance ciliated infusoria appeared, and thus no confirmation of his views was obtained concerning the dependance of organization on mass. It should however, be remarked that all the creatures were minute. Some larger specimens were found after three or four weeks, but not one of full size.

I have thought it might interest the readers of the INTELLECTUAL OBSERVER to call their attention to these simple observations, as analogous experiments are easily performed, and although few persons would be disposed to adopt M. Pouchet's theory in its entirety, the real influence exercised by the mass of fermentible or putrescible matter present in an infusion is well worthy of research. In every instance I obtained animals of high organization under the conditions described.

THE DEVIL-FISH OF JAMAICA.

BY THE HON. RICHARD HILL.

THE *Cephaloptera* taken in Kingston harbour, on the 10th of April, which I am about to describe, though small, being only four feet in breadth from the extremity of one pectoral to the other, and but two feet one inch and a half from the centre of the head to the dorsal fin, situated at the extremity of the trunk, with a length of whip-like tail, two feet six inches more, —exhibits all the character of the *Cephaloptera Massena* of Risso. As this specimen of a Devil-fish, the smallest with which our fishermen are acquainted, was a gravid female, having within it a fœtus just mature for extrusion, sixteen inches broad, I take it to be a species distinct from any hitherto no-

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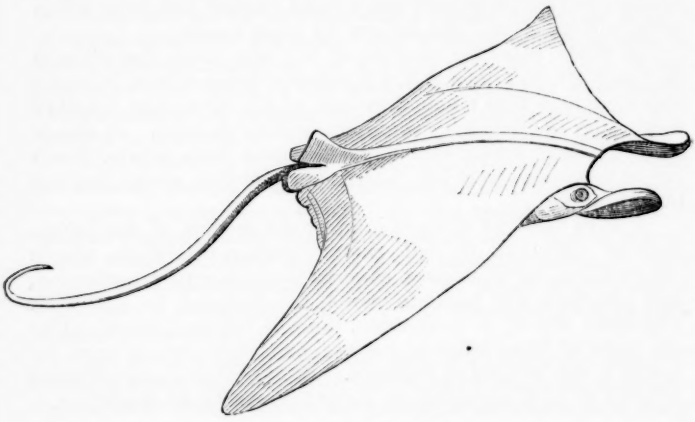
ticed. It does not resemble the monsters that have been described as common with us—its length of tail being a peculiarity not recorded in any of the accounts of devil-fishes taken in Kingston harbour. The back curves regularly, so that it looks humped; the eyes are lateral, being in the vertical wall of the head, with air valves behind each eye. The tail extends immediately from the angular dorsal fin at the extremity of the trunk. The colour is dark vinaceous violet, and green about the curvature of the head—the under parts are white. It will be seen that the Cephaloptera Massena closely represents the fish I am about to notice in all things but diminutive magnitude.



THE DEVIL-FISH OF JAMAICA.

"The species Massena," the great fish of the Mediterranean, says Risso, "until lately unknown to naturalists, is dusky black above, and dull white beneath. The head wide, is as if it had been cut straight along, and is furnished on either side with what is called a horn—a prolonged part of the fin—composed of cartilaginous rays like the pectoral. The two appendices of the head are on their inner side of a white silvery hue, with the extremities black. They display motion at will, directed towards the object the fish desires to approach. The mouth is very wide, and nearly square. The upper lip, ridged with a fleshly membrane, has several ranges of teeth overspreading the upper jaw; the lower is covered with a similar set of teeth in a silver-tinted band. The iris of the eye is of a dull yellow, with the pupil black. The pectoral fins are triangular, with an upward curvature, and two ventral fins are

between the pectoral and the dorsal fin. The long slender tail has three angular surfaces, and diminishes to a point."

The monstrous skate, said by Père Labat to have been observed by the negroes of Guadaloupe, and described as fourteen feet French broad, and ten feet from the head to the commencement of the tail, with the tail fifteen feet more, and altogether twenty-five feet long, was obviously a kindred ray to our devil-fish; and the monster spoken of by the early voyagers as suffocating the pearl divers, and known by the name of *Manta*, was a similar animal. But the devil-fishes, best known in Kingston harbour, which we will notice by and bye, differ from these species by having a tail short in length, but agreeing with the specimen recently taken, in being without any serrated spine, like the sting of the sting-ray.

I feel surprised that so careful an observer of distinctions in species as Mr. Yarrel, should have entertained the supposition that Risso, in recording two Mediterranean Cephalopteras, had mistaken one and the same species in two conditions of growth,—the *Giorna*, and the *Massena*. He says:—"I am aware that M. Risso considers he has found, in addition to the *Giorna*, a second species in the vicinity of Nice; but several good authorities believe that his examples of *Cephaloptera Massena* are only old and large specimens of *Cephaloptera Giorna*." Now, independent of the precise distinctions set down by Risso in the two species, he mentions as particular differences the tail spine that is present in one and wanting in the others. His words are conerning the Giorna, "aculeo longissimo ad basin caudæ apterygiæ;" and Massena, "aculeo nullo in caudâ trifariam aspera." This is a very important difference. The aculeus or sting is wanting in all our Cephalopteras, and the lengthened tail is found only in the species I now notice. In that respect it agrees with Father Labat's monster of Guadaloupe, and differs from Le Vaillant's Atlantic specimens, and from the enormous fishes described by Lieutenant Lamont in the *Edinburgh Journal of Science;* and from the gigantic ray taken in Delaware Bay by the smack "Una," and described by Mr. Mitchel in a letter to the president of the New York Lyceum of Natural History, in 1823. Having made these introductory remarks, I shall proceed to give my notes of the fish of April the 10th.

The position of the eyes is peculiar; the direct vision, that is, the seeing of objects immediately ahead of the fish, is cut off entirely by that projecting extension of the pectorals at their junction with the head, which gives the head the appearance of having horns. A divergence of the pectoral fins here forms two flat flaps when opened out, but they are always vertically rolled up, twisted like a coiled leaf, with a twirl that

fashions it into a groove, through which the water can pass as through a cylinder, when the fish glides onward. Between these two horned processes of the head, horn-like in appearance, but not horn-like at all in structure, extends the crescent curvature of the head, beneath which opens the wide cavity of the mouth. It stands constantly open, the fringes of the five plates of gills being seen to stretch from one side to the other of the vocal floor. The eyes are placed in the straight vertical walls of the head, for the head is very angular. They are, consequently, capable of surveying objects only laterally. One sees clearly that the habit of the Cephaloptera is that of a ground-feeder. It is formed for shoving through the fields of turtle-grass, *testudinaria*, but, unlike the rays which are likewise ground feeders, it does not seize its prey on the ground, but pushing on through the marine herbage, it takes into its wide open mouth the congregated living things that are in its way—it may be the fish that nestle in the vegetation, or the naked mollusca that depasture there—at once swallowing them, or rather cramming them in with its cranial arms into its mouth and

stomach, without deglutition, having no œsophagus. As the animal in this gathering in of food cannot see forward, it must depend on casualties in the course it steers through the marine meadows for prey. The rolled-up head-fins between the crescented head, sufficiently direct the food to the mouth. The pectorals have the ordinary arrangement of the fins of rays. They move the fish onward by successive flaps, alternately right and left, and left and right. The figure of the fish is flattened, but not flat; the back is round and humpy; the dorsal fin is small and angular, and situated at the commencement of the tail.

"Most men," says White of Selborne, "are sportsmen by constitution, and there is such an inherent spirit for hunting in human nature, as scarce any inhibitions can restrain." Port Royal, usually exhibiting no stir of life out of the garrison or the dockyard, is thrown into a state of bustle and excitement at the intelligence that the naval and artillery officers are away for a day's sport with the devil-fish. Every boat on the beach is launched, and canoes in numbers are seen gliding rapidly, where it is announced that the harpoon has struck a sea-devil. A string of vessels is now fastened to the boat that contains the

harpooner, and the retinue is towed away to sea for miles by the monster fish. If they bring him in, a team of oxen—if there were ever such a thing as a team of oxen in Port Royal—would not be able to drag him ashore. Just before I visited Port Royal, some seven years ago, the garrison officers had brought in two fishes after one of these exciting chases, but I learnt little more than that they were captured. A graphic narrative of the taking of two devil-fishes some five-and-thirty years ago, will be found in the eleventh volume of the *Edinburgh Philosophical Journal*, and this narrative, which was communicated by Lieutenant Lamont of the 91st Regiment, I will condense and give here.

The lieutenant had been called to the beach by seeing a multitude gathered to look at a sea-devil floating past. His curiosity turned to surprise when he saw flapping on the surface of the water, about twenty yards from the shore, a large, living, dark-coloured mass, whose shape and size he could not immediately determine, but which seemed prodigiously big beyond anything he could conceive, since it so much exceeded all that he had seen or heard of fishes. The boats were started off to pursue it passing onward. It was harpooned; but no sooner was the monster stricken, than it made off with amazing velocity, towing the boat of the harpooner after him. A succession of boats now came up. These strung themselves on to the harpooner one ofter another, striking each a harpoon as the boats came up. They consecutively formed a long line, but such was the strength of the fish, that the whole retinue were trailed out ten miles to sea. Night was drawing on. To bring the chase to a close another harpoon was struck into the monster, when it made one convulsive effort to get away, and broke loose, carrying away eight or ten harpoons and pikes, and leaving every one staring with astonishment at the success with which it snatched itself eventually from its pursuers.

Lieutenant Lamont gives another account of the taking of a devil-fish within the harbour, when the animal traversed up and down, dragging with such velocity the boat that struck him, that those who followed could not overtake it. The struggle of this monster to get away was tremendous. He plunged in the midst of the boats that now surrounded him; he darted from the surface to the bottom of the water, and from the bottom to the surface alternately, dashing the water into foam on every side, and rolling round and round to extricate himself from the pole and line. Unable by these expedients to get away, he set to swimming and towing the boats now strung together. After continuing this run for a time, this sea-devil then suddenly brought the retinue to a stop by laying himself at the bottom of the water. From this po-

sition the stretch and strain of all the boats pulling away from him, could not move him. Slackening their tension they enticed him inch by inch to rise. He once more was afloat, when a shower of musket-balls and pikes literally riddled him through and through. Though wounded in this way, he still floated alive. Until this capture was effected by Lieutenant St. John of the artillery and his military companions, it was supposed that a sea-devil was beyond the main and might of human art or strength. The dimension of this fish was not more than half that of the common size—it was only fifteen feet in width. A man, however, entered its mouth with ease, the space being two feet and a half.

Lieutenant Lamont says, that wishing to know what the sea-devil fed upon, he saw the stomach opened. It was round, and studded with circular spots of a muscular substance. It had transverse muscular layers from one end to the other, and contained nothing but slime and gravel. The weight of the fish was so great that with difficulty forty men, with two lines attached to it, dragged it along the ground.

In the account of the fish taken in Delaware Bay, it is stated that, drawing a boat after it with the celerity of a whale when harpooned, it caused a wave to rise on each side the trough of the sea several feet higher than the boat; that during the scuffle the vast fins of the fish lashed the sea with such vehemence that the spray rose to the height of thirty feet, and rained dropping water around to the distance of fifty feet; and yet the measurement of this fish was only half that of the generality of those seen, being only eighteen feet in breadth. Three pairs of oxen, one horse, and twenty-two men, all pulling together, with the surge of the Atlantic to help, could barely convey it on to the dry beach.

When Lieutenant Lamont speaks of the cavity of the mouth being so wide that two men could be seated within it, it must be remembered that the Cephaloptera—added to a much greater degree of extension than is common with the ray tribe—has a mouth and stomach constructed without any intervening œsophagus. Both form together but one cavity, and the dimensions are disproportionately large to the bulk of the body.*

The largest of these fishes that ever came under my own eyes was when I was on board a vessel of Bordeaux, on my way from Haiti to France. We had just cleared the last of the Bahamas, and as we gently scudded onward with the wind on our beam, we sailed close along one of the Cephalopteras

* Lorenzini's account of the torpedo's structure is:—"Lo stomacho e continuato con la bocca, una sola, et una medisima cavita, la quale a proporzione de la animal è vasta." Quoted by Dr. John Davy, in his account of the torpedo *Researches Physiological and Anatomical*, vol. ii.

leisurely flapping and floundering on the surface of the broken water, striking first one fin into the air and then the other, and presenting a bulk of living flesh half the dimensions of the vessel. The sea-devil is the fish that Barrère and other travellers speak of, of such uncommon dimensions, springing above the surface of the sea, and splashing the water to an immense height when falling into the sea again. It was these fishes that Le Vaillant saw in his second voyage to Africa, the smallest one, which he caught, being twenty-five feet long in the body, and some thirty feet wide in the fins. It is of this fish that Sonnini speaks when he represents a flat fish seen on the surface larger and wider than the vessel he was sailing in. The most interesting narrative is that of Risso, of a fish taken in 1807, in a net at Nice, called a mandrague, a net divided into chambers, and stretched out with anchors, and gathered in by boats. It was a female, *Cephaloptera Massena*, the *vacca* of the Mediterranean fishermen. It weighed 1328 lbs. avoirdupois. When the female fish had been taken, the male, which was afterwards captured, and weighed 885 lbs., haunted for two days the spot where its mate had disappeared. The female had been trussed up, by having its tail stuck into its gills. In this posture it moaned piteously. The companion fish wandered round and round the nets, searching for it, and was finally taken in the same mandrague in which its mate had been caught, but was quite dead. There is something amusingly touching in this love of sea-devils —the moaning captive, and the woe-begone wanderer seeking his lost one, with the lover finding no solace but in dying in the toils in which the object of his affection had perished.

Are we to take the occurrence related by Colonel Hamilton Smith, in the *Boca del Drago* of Trinidad, as appetite or mere devilry? He says that just after daylight, a soldier from the ship he was in was observed by the man in the maintop deserting, swimming from the vessel. He was called on to return, but just at the moment a devil-fish threw one of his fins over him, when he disappeared, and was seen no more.

The sea-devils luxuriate much upon the surface of the sea. In Kingston harbour, where at times they are common enough, they have excited great apprehension by being unexpectedly approached floating on the surface, or swimming just beneath it. The horn-like processes, mistaken for a mouth wide open; the flapping fins so much apart, creating misconceptions of the form of the fish and of its dimensions, and increasing the dread of danger at a distance; and even the disregard of the fish for objects out of the range of its lateral vision, in seeming to be in pursuit of what may be ahead, when it is only indifferent about avoiding it, because it does not perceive it, are incidents that terrify. Sometimes the evening excursionist, on the quiet moon-

light waters of the harbour, has been alarmed by a sudden drenching billow in a tranquil sea, nothing being seen to account for the unexpected wave, the fact being that a devil-fish at the moment had been neared by the boat, and had heaved the waters with its fins in hastening away. Fortunately, the Cephaloptera is not as frolicsome as it congeners, the sting-rays. The *Trygon* and the *Myliobatis* will frequently spring out of the water, and pitch themselves on to a distance like quoits. The Cephalopteras are only fond of sauntering about in the sunshine, flapping their breadth of fin in and out, first one fin and then the other. In an early morning sail that I took some years ago from Passage Fort to Kingston, amid the stretch of shoals there, with their clumps of mangroves,* the devil-fishes were to be seen dotting the waters like lotus-leaves in a pond. It is on the sands thereabout that the *Scyllium cirratum* will be found basking by hundreds in the month of July. This scyllium is the nurse-shark, and to these banks the fishermen go to "strike" them, as they phrase it, and take them for their oil. Here a multitude of fishes will be seen sporting at early morning. The *esox* amuses itself with leaping from left to right and from right to left over every stick floating in its way. Here the *Hemiramphus* will be observed spinning along the smooth sea in successive skips, with only his tail in the water, which he uses like the propeller of a screw-steamer; and here we meet with our cetaceous dolphins rolling and tumbling. Inhabitants of the water are very frolicksome in the uprising daylight. I confess that when I see their sportiveness, the evidence of their exuberant enjoyment of life, their swimming hither and thither, sometimes few and sometimes many together, swift or slow, gentle or rapid, just as it pleases them, the element seems to me to have in it that especial pleasantness exhibited by a parcel of boys in a morning bathe. Water has a feeling of comfort exceedingly appreciable, and I think, above all, sea-water.

The Cephaloptera seem to me to include in the different forms of their numerous species (for the species are undoubtedly many) all the caudal diversities of the ordinary ray, or skate family. Some have the whiplike tail of the *Trygon pastinacstæ*, armed with the serrated spine, as the *giorna* of the Mediterranean; some the same flagelliform tail, lengthened and small in diameter, as in the *Myliobatis aquila*, but without the caudal spine, as in the specimen here particularly described, which I would call the *Massenoideæ*; others are short-tailed and spineless, as in the *Raia batis*, or tinker skate of Norfolk (England). Such are the monster skates of Kingston harbour described by Lieut. Lamont. Again, the caudal fin is forked, or double-lobed, as

* For a very interesting account of the mangrove-tree, see Gosse's *Naturalist's Sojourn in Jamaica*, pp. 245—7.

in the torpedo. Such was the form of the tail in the Atlantic specimens taken by Le Vaillant in his voyage to Africa. All these differences elevate the Cephaloptera into a family of the *Plagiostomi*, as distinct as the squatina is from the raia, or the torpedo from the trygon.

Risso concludes his description of *Cephaloptera Massena*, the great monster fish of the Mediterranean, with these observations. He says:—"It is a fish of dimensions so extraordinary, of a shape so remarkable, and endowed with such singular affections, that one undoubtedly feels astonished it has remained unknown till now, living, as it does, in a sea in which systematic fishing has been carried on for so many ages. It is true that it is exceedingly rare, and that its capture is always looked upon as a presage of great events by those whose minds yield to prejudices. These fishes, however, come near shore only when they are driven in by storms."*

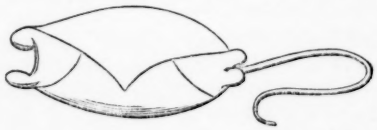
One cannot contemplate the expanse of flesh in a sea-devil without wishing for a sight of the giant economy when the skin is removed, with its numerous phalanges divided into parts; its cartilaginous belt, girding in the cavity of its mouth and stomach; its carpal bones, its pelvic apparatus, and that cranial expansion with its adaptation for scooping in food. The gigantic mass would present a prodigious map of the structure of the fish.

The Cephaloptera affect the surface waters to obtain the necessary degree of warmth for the maturation of the fœtus, the fish being viviparous. Our fishermen say that the mother fish makes the violent leaps she is seen to take out of the water to eject the fœtus from the matrix; that the young fish is then observed to fall from her; and that for a time it swims upon the parent's back, and possibly enters the wide mouth-sack when necessary to seek shelter from apprehended danger. As approach to these monsters is always hazardous, the observation of such a fact as this last must ever be casual and doubtful. Nothing is certain but that its habits are peculiar. Le Vaillant, when speaking of the three fishes he saw in 10° 15′ north in the Atlantic, one so large that it seemed fifty or sixty feet wide, relates that they all three carried each on his horns a white fish about half a yard long, which appeared to be stationed there on duty as

* Le Cephaloptère Massena, est un poisson dont les dimensions sont si extraordinaires, les formes si remarquables, et les affections si singulières, qu'on sera sans doute étonné qu'il soit resté inconnu jusqu'à ce jour; quoique vivant dans une mer sur laquelle l'art de la pêche s'exerce depuis tant de siècles. Il est vrai qu'il y est fort rare, et que sa capture y est toujours regardée comme un présage de grands événemens, par les esprits soumis aux préjugés. Ces poissons ne s'approchent des rivages que lorsqu'ils y échouent par l'effet des tempêtes.—*Ichthyologie de Nice, ou Histoire naturelle des Poissons du Département des Alpes maritimes*, par A. Risso, Membre associé de l'Académie Impériale de Turin. Paris, 1810.

sentinels to keep watch for the safety of the devils, and to guide their movements; that these sentinels passed over their backs when they rose too high, and repassed under them till they descended deeper, disappearing and being seen no more for a time, but reappearing and resuming their post as sentries, when the fish again ascended to the surface. These remarkable habits render the story of the young devil-fish swimming on the mother's back a probable occurrence. "During the three days," says Le Vaillant, "that the calm continued, and the ship remained motionless, these occurrences were many times repeated before the eyes of all on board as to each of the three monsters." These facts relate to the Remora or sucking-fish, but they illustrate the habit of the sea-devils, and possibly explain their association with their young, and their appearing to swim on the back of their mother-fish.

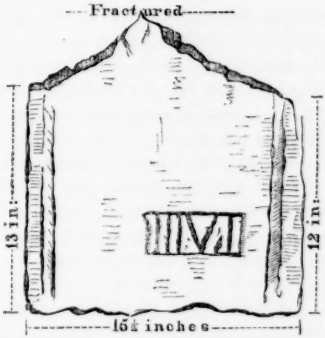
I have said the fish taken on the 10th of April in Kingston harbour, and named by me *Cephaloptera Massenoidea*, was a gravid female. The fœtus was in the stage just prior to birth. The colour on the back was as intensely violet as in the mother sea-devil, and the whip tail just as firm; the radial cartilaginous plates of the head lay flattened. The flukes of fins were folded over the back, lapping one another thus:—



The fins when extended were 16 inches across, the length of the body from head to the tail 24 inches.

Cephaloptera are taken in other harbours of Jamaica beside Kingston. On the 4th of May, 1854, a female devil-fish was caught in Montego Bay, another being seen at the same time in company. There being no shoal-banks about Montego Bay, the sort of grounds they resort to, these fishes had probably strolled from the Cayos opposite, the "Jardinas, or Gardens of the Queen," on the coast of Cuba, a prodigious feeding ground for all our tropical fishes.

[P.S.—Since the above was written the Hon. Richard Hill has communicated an account of another "sea-devil," caught in Kingston harbour on the 18th of April. In this specimen the cranial arms were flat, and not coiled up as in the fish of the 10th; the position of the eyes was different; the tail was only two feet long—quite a rudimentary proportion compared with the body, which was nine feet six inches long, and fifteen feet six inches wide across the expanded pectoral fins.]



ON AN INSCRIBED ROMAN TILE RECENTLY FOUND IN LEICESTER.

BY THOMAS WRIGHT, F.S.A.

In the course of excavations made in the year 1854 in Bath Lane, in Leicester, the workmen found, among other relics of the Roman town of Ratæ, a broken Roman tile, which presented in itself no particular interest. It was an ordinary roof-tile, flanged at the sides, measuring in breadth fifteen inches and a half, and in its present condition, for it is broken at one end, twelve inches on one side and thirteen on the other in length. When perfect, it perhaps formed nearly a square. On examination, however, this tile was found to bear stamped on its surface a legionary mark of considerable interest in regard to the history of our island under the Romans; considerable, I may state, only on account of the very faint glimpses history has spared us of the events which occurred in Britain from the second to the fourth century. It may be taken, indeed, as a very good example how relics of apparently little importance may often throw great light on our primeval antiquities, and how cautious we ought to be in despising or rejecting anything. To explain the interest of this old broken tile, it will be necessary to review briefly the history of the Roman legions employed in conquering and retaining this distant province of the empire.

It is hardly necessary to state that the military force of Rome was originally divided into a certain number of legions, the strength of each varying at different periods from four thousand to six thousand infantry, with about three hundred cavalry. In Cæsar's first expedition to Britain, he brought with

him two legions, which were, as we learn in the course of his narrative, the seventh and the tenth. In his second expedition he brought five legions with him; we know, from an incidental mention of it, that the seventh legion was one of them, and the tenth also probably accompanied it, but the names of the other three are unknown. As on the former occasion, these legions were all withdrawn on Cæsar's departure, and Britain was not again visited by Roman troops until the accession to the empire of Claudius, who, in the year 43, sent Aulus Plautius into Britain at the head of four legions, which are known from various authorities to have been the second, ninth, fourteenth, and twentieth. The first of these was commanded by Vespasian, the future emperor, and they seem to have been all what we should now term "crack regiments," proud of their reputation, and, under the influence of this pride, very ready to mutiny. Under the proprætorship of Sultonius Paullinus, the ninth legion only appears to have been left in the south, while the three others were employed, under Suetonius in person, on the borders of Wales, the second legion being especially occupied in establishing itself in the country of the Silures. At this time, no doubt, the Roman town of Isca, now Caerleon, in Monmouthshire, was founded, as well as Deva or Chester, the former to be the head-quarters of the second legion, the latter of the twentieth. It is well known that in the revolt of Boadicea, in the year 61, the ninth legion, which had attempted alone to arrest the progress of the insurgents, was nearly destroyed, and that Suetonius hurried to suppress the insurrection with the fourteenth and twentieth legions, leaving the second in the country of the Silures. Two thousand soldiers were sent from the continent to recruit the ninth legion, but, as far as we can judge from the accounts of what it had suffered, this number must have been very insufficient. The civil commotions which soon disturbed the Roman empire, prevented the arrival of further recruits during some years, while, besides other troops which were carried away from Britain to assist in the struggle for power, the whole fourteenth legion was carried to Italy by Suetonius Paullinus to support Otho against Vitellius, the latter being, as it appears, universally unpopular among the soldiers in this island. When Vitellius had secured the empire for himself, he was probably glad to remove the brave and not very loyal fourteenth legion to its distant province, and it returned to Britain with the new proprætor, Vettius Bolanus; but when Vespasian, who was personally known to the legions in this island, and was as popular among them as Vitellius was detested, sought to obtain the imperial purple, the fourteenth legion crossed the channel to assist him, and left Britain in A.D. 69, never to return. The number of

Roman legions in this island was thus reduced to three, the second, the ninth, and the twentieth.

All that we know of the subsequent movements of the Roman legions in Britain, which is very little, is gathered from one or two slight allusions in the Roman writers, and from inscriptions found on monuments which have been from time to time discovered on sites those legions had permanently or temporarily occupied. These inscriptions generally are of three kinds, those on tomb-stones, or dedications of altars, etc., or inscriptions relating to buildings which they had erected or repaired. The tomb-stones, commemorating only the deaths and burials of individuals, are but of secondary value, because the fact of the death and burial of an officer or soldier of a legion in a certain place does not necessarily imply that the whole legion, or even any considerable part of it, was there. The votive monuments are of more value; but the most important of all for our purpose are the inscriptions recording work performed by the soldiers. The Roman legions, in this respect unlike the troops of modern times, were never allowed to be idle; when not engaged in hostilities, they were employed on public works, such as making roads, throwing up fortresses, and erecting public buildings of various descriptions, and they commemorated their labours by inscribed tablets of stone, on which in some cases (especially in building defensive walls of great extent) the quantity of work performed by each detachment was stated, or by stamping merely the name of the legion on the tiles or bricks used in the construction. These last mentioned inscriptions are found in great abundance on the sites of the towns which were occupied by the legions.

When Julius Agricola undertook the conquest of the Caledonians, he no doubt carried with him to the north the three legions then in Britain. He was himself the commander of the twentieth legion, and we learn from Tacitus that the ninth legion took part in the decisive campaign against Galgacus in the year 83. This legion appears never to have recovered the losses it had sustained in the war against Boadicea, and it is described by Tacitus as being at this time weaker than the others; yet it was unfortunate enough to be left in an exposed position, where it was surprized and almost cut to pieces by the Caledonians. After this event, the ninth legion disappears from history, and the effective legionary force in the island appears to have been almost reduced to the second and twentieth legions. But when, in the year 120, the Emperor Hadrian repaired into Britain in person to put a check upon the attacks of the formidable Caledonians, he brought with him another legion, the sixth, which had been previously established on the borders of Germany. The emperor had with him in the north, with

this new legion, the second and the twentieth, for numerous ascribed monuments still attest the work performed by each of these three legions in the erection of the great wall which by his orders was carried across the island from the Solway to the Tyne.

I must now speak of another peculiarity of the Roman military system, namely, the custom of establishing the different legions through the various parts of the empire in permanent quarters, which the same legion continued to occupy until the empire itself was broken up. We trace, in the narrative of Tacitus, the second legion establishing its quarters in the country of the Silures as early as the middle of the first century, and the twentieth was no doubt stationed at Deva about the same time; while inscriptions found at York leave little doubt that that city, called by the Romans Eburacum, was the station of the ninth legion, which had probably been placed there as a check upon the incursions of the Caledonians. The entire disappearance of the ninth legion after Agricola's last campaign in the north, has been explained by the probable supposition that Hadrian found it so greatly reduced in numbers that he incorporated it with the sixth legion, which he had brought with him from Gaul; and this, again, will explain why the quarters of the sixth legion were subsequently established at Eburacum. In the geography of Ptolemy, usually ascribed to the year 120, and apparently compiled very soon after the date of Hadrian's visit, these three legions only are enumerated as being then in Britain, the second legion at Isca (*Caerleon*), the sixth at Eburacum (*York*), and the twentieth at Deva (*Chester*). Tiles, with the legionary stamps of the second and twentieth legions, have been found in some places in Wales, and probably mark stations at which detachments of those legions were often posted, for reasons with which no historical records have made us acquainted; but the three legions just enumerated were never moved from their permanent head-quarters, until the time when the imperial authority was withdrawn from the island, and we have no account of the presence of any other legion in Britain. When, in the reign of Antoninus Pius, twenty years after Hadrian's expedition, the proprætor, Lollius Urbicus, marched against the Caledonians, he took with him all the legions in Britain, and the numerous inscribed slabs commemorating the building of portions of the great line of defence known as the wall of Antoninus, which have been found from time to time, make us acquainted with the share each of these three legions, and no others, performed in it. In the struggle for empire which ended in the elevation of Severus to the purple, in A.D. 197, the troops in Britain supported the claims of Albinus, and some portion at least of the legions went over to

the continent to fight in his cause; but they appear to have returned to their old quarters soon after his defeat, for in the record which is known by the title of the *Itinerary of Antoninus*, and which is supposed to have been compiled about the year 320, we still find the second legion at Isca, the sixth at Eburacum, and the twentieth at Deva. About a century later, on the eve of the final withdrawal of the Roman legions, when the official work known as the *Notitia Utriusque Imperii* was drawn up, it appears from that important record that the twentieth legion had already been withdrawn from the island, and that the second legion had been removed from Isca to Rhutupiæ (*Richborough*, in Kent), probably on its way to the Continent, but where it remained under the disposition of the count of the Saxon shore; but as the sixth legion is there stated to be under the disposition of the *dux Britanniarum*, whose authority extended over all the garrisons in the north of Britain, it no doubt still remained in its quarters at Eburacum. None of these records intimate the presence of any other legion in Britain.

It must thus be a matter of some surprise when we find a monument recording the presence of the eighth Roman legion at Ratæ (*Leicester*); yet such is the case with the tile of which we are speaking, and which, with its stamped inscription, is represented in the accompanying cut. This inscription is easily read as L.VIII. The letters are, as will be seen, reversed, which is not very unusual on the stamps of the legionary tiles, and is explained without difficulty. The stamps for the pottery, and for other articles for sale and for domestic purposes, were engraved deliberately and with care on metal or stone, because they were intended for permanent use; but when the soldiers of a legion were proceeding to the erection of a building, and made the tiles for it, they probably cut their stamp hastily on a piece of wood for the occasion, and at times a worthy soldier thus employed forgot that what he thus cut on the stamp would be reversed in the impression. Examples of similar reversed inscriptions on the Roman tiles, made by soldiers of the second legion, will be found in Mr. Lee's excellent and valuable "Catalogue" of the antiquities collected in the Museum at Caerleon, recently published. The form of the letter L is another peculiarity of this stamp, for, though it is found in other inscriptions, it is not very common. It occurs in the inscription on an altar dedicated to the Deæ Matres found at York, the date of which is uncertain. It is also met with in an interesting Roman inscription on the rock of the Roman stone-quarries on the bank of the river Gelt, near Brampton, in Cumberland, which is engraved and described by Dr. Bruce, in his well-known work on *The Roman Wall* (page 64 of the second edition).

This inscription also is the work of legionary soldiers, and informs us that it was made by men of the second legion, when they were employed in quarrying here in the consulship of Flavius Aper and Albinus Maximus, which fixes the date to the year 207. It appears, indeed, that this form of the letter L was in use during the third century. It may be further remarked, that the peculiar character of this monument of the eighth legion has its significance. A mere tablet might have implied simply that the legion in its march had halted to raise or repair some work of defence; but a tile, and that a roof-tile, marked with the name of the legion, shows that the soldiers were employed in erecting buildings of a different character, and those buildings were most probably for their own accommodation. They were, in all probability, barracks. The tile thus furnishes strong evidence that the eighth Roman legion was stationed for some time at Ratæ, or Leicester, probably at some period in the third century.

We are not very well acquainted with the history of the movements of the eighth legion. It appears to have been stationed on the borders of Germany, and Mr. Roach Smith, in the second volume of his *Collectanea Antiqua* (page 140), enumerates tiles bearing its stamp found at Niederbieber, on the Rhine, which show that it was at some period stationed there. We have no intimation in any historical record of the sending of this legion into Britain, and the date and object of its visit are, therefore, left entirely to conjecture. If it had come over hither with Severus, it would hardly have been left at Ratæ, but would more probably have been taken to the north; and we have no reason for supposing that that emperor brought a legion over with him. But the latter part of the same century was the age of Carausius and Allectus, and when Constantius came over in 292 to restore the rebellious province to the empire, and had need of a very formidable army (as the three legions in Britain would be arrayed against him), it is extremely probable that he brought even more than one legion over with him. The eighth legion was ready at hand, as Germany and Gaul were in his division of the empire. Constantius, victorious, established his residence at Eburacum (*York*), which was now considered as the military capital of Britain; and as he came not to meet a foreign enemy, but to restrain a rebellious population, it is not at all improbable that, during his stay here, which ended only with his death, he may have stationed a legion at Ratæ.

Thus, in this inscribed tile, accidentally preserved, we have, perhaps, the only monument remaining of one of the most interesting events in the annals of our island during the Roman period, and one of which the history is very obscure, the re-

conquest of the province by the Emperor Constantius, the father of that Emperor Constantine who went from Britain to make Christianity the State religion of the Roman empire. How many such monuments, in appearance worthless, but which might have assisted in throwing great light on the history of our country, have been destroyed through the ignorance of those who happened to find them! It ought surely to be a warning to us to be cautious in rejecting or neglecting any relic of antiquity, because it may appear at first sight of small value or of trifling importance.

ORGANIZATION AND LIFE.*

From the earliest ages of speculative thought, the human mind has occupied itself with the vast and perplexing questions of organization and life; but notwithstanding centuries of experience to show the proper limitations of such an inquiry, it is still rare to find a writer or an investigator who will adhere to an inductive method, and abstain from mingling the guesswork of mere hypothesis with the pursuit of experiment, or the elucidation of fact. An inquiry into organization necessarily belongs to the domain of physical science, and demands physical methods of procedure, which are incapable of dealing with elements of a purely metaphysical kind. Physical science reveals a wondrous order and harmony of forces and arrangements, extending through all the time and all the space with with which we are acquainted; and as our minds take cognizance of such facts, we are irresistibly led to the contemplation of an Intelligent First Cause. Let us, however, distinctly understand that it is not a mechanical process, a chemical process, or a physiological process that conducts us to this result; all that the physical sciences do is to give us information, about which we cogitate according to the laws of thought, and thus arrive at a perception of their connection with a class of powers that no physical methods can reach. The apparatus of the chemist, the scalpel of the anatomist, the microscope of the minute inquirer, or the telescope of the astronomer, cannot be employed without displaying to us the results of Will, Intelligence, and Design; and yet it cannot be said that it is through them that we learn the primary truth concerning the Source and Origin of all the phenomena which Nature presents. An

* *La Vie et ses Attributs dans leurs rapports avec la Philosophie, l'Histoire Naturelle et la Médecine*, by L. Bouchut, Médecin de l'Hôpital Sainte Eugénie. Professeur agrégé de la Faculté de Médecine, Chevalier de la Légion d'Honneur, Baillière.

XUM

inquiry into life requires the combinations of physical and metaphysical methods, because under the term life we include things which differ as widely as human emotion and the development of an egg. We say life is one, and we say nature is one, but we do not mean to assert that there is no difference between a granitic mountain and a shooting star, nor ought we to forget the distinction that separates the function of digestion from an impulse of the mind. To call life a *principle* is to place ourselves on the highroad to confusion, because we start with a definition which assumes a knowledge that we do not possess; and we moreover jumble together a variety of causes and effects.

A principle means a *beginning* of some kind. The principles of a science are those elementary facts and conceptions which form its foundation. In another sense, a principle is a first cause. We likewise find that principle is often used to signify not a sense, but a nonsense, and thus we hear of the "electrical principle," the "caloric principle," the "vital principle," or any similar phrase intended to give ignorance a learned look. If we take life to mean all the acts and properties exhibited by living beings, our first business is to separate them, and study each class in an appropriate way. The phenomena that belong to physical science will have a physical cause for their appearance; and a physical cause is not a volition, or an intelligent power, but simply a condition, or assemblage of conditions, that are invariably followed by another state of things that we call an effect. If we ask *why* there is this invariable link between certain antecedents and certain consequents, physical science cannot tell; and it is a metaphysical science that resolves the difficulty by pointing to that Intelligence which is the Great Cause of all.

Those who are curious to study the history of opinion on the question of vital manifestations will find it ably traced in Barclay's *Life and Organization*, and it is interesting to note that, so early as Empedocles, a bold effort was made to avoid the confusion into which investigators are still apt to fall. According to that philosopher every animal possessed a rational and a sentient soul, the former derived from the gods, the latter from the four elements of which it was imagined that the universe was composed. In this rude hypothesis there is an attempt to separate the phenomena of organic life from those of consciousness, which we do not find in M. Bouchut, the latest writer on the same subject, who tells us that "by *vital force* matter *feels*, *moves*, and assumes *forms* more and more complicated, from the creation of vivifiable organic matter to the most completely organized being." This same "vital force" which has bewildered so many subtle heads, M. Bouchut considers he has "de-

monstrated" to be "extra-organic," and he calls it "an *intermediary of the soul*,"* whose mysterious union with the body represents the entire being. Plunging thus headlong into conjectural metaphysics, we are not surprised to be told that "life creates in each species of creatures the special organs that are to serve as the instruments of its activity. The functions create the organs, and after that all goes on by the mediation of physical laws." We hope this learned Professor does not represent the condition of French intellect dwarfed by Napoleonic despotism; but we read with astonishment his arguments to prove the strange theory we have announced: "All vegetables and animals *feel*," so runs the book, and they do this "with or without organs of sensibility; they all *breathe*, but with different organs of respiration, from the plants which have no respiratory apparatus, and certain animals that breathe through all their tissues, up to insects which respire through trachæal tubes, fish that have gills, and birds and mammals that possess lungs." "Here is a fact," exclaims our author, "which proves against those who contend that the organ creates the function; and it is infinitely more true to say that the function creates the organ." Whether the animal be a symple polyp or a complicated man, the function is not performed until there is an organ to perform it; the difference is that in the higher creature an immense advance has been made in the adaptation of a special structure to a special use.

Even apart from intellectual manifestations, it is clear that living beings do things that are not done by inorganic matter; but we are not entitled to ascribe the whole assemblage of such acts to a "vital force," or some entity totally distinct from any physical force; nor should we say that "when once *life is incarnated in matter*, it produces effects which in their turn act as causes," and so forth. We can trace the circumstances under which an animal lives, but, apart from religious ideas, we have not the faintest conception of *why* it lives, nor will physical science help us in the research. In his great work on *Logic*, John Stuart Mill remarks that although it would be an important addition to our knowledge, "if proved, that certain motions in the particles of bodies are among the *conditions* of the production of heat or light; that certain assignable physical modifications of the nerves may be the *conditions* not only of our sensations and emotions, but even of our thoughts; that certain mechanical and chemical *conditions* may, in the order of Nature, be sufficient to determine to action the physiological laws of life;" still, "it must not be supposed that by proving these things, one step would be made towards a real explanation of heat, light, or sensation." In the same spirit, Bacon warns us

* *Intermédiaire de l'âme.*

"not to suffer the understanding to jump and fly from particulars to remote and most general axioms (such as are termed the principles of arts or things)," and he adds, "we must not even add wings, but rather lead and ballast to the understanding, to prevent its jumping or flying, which has not yet been done; but whenever this takes place we may entertain greater hopes of the sciences." Had M. Bouchut followed the Baconian advice he would not have told us that the "three attributes common to everything endowed with life are, (1.) *impressibility*, or the unconscious faculty of feeling external impressions without any participation of the nervous system; (2.) corpuscular movement, automatic movement, or *autocynesy*, that is to say, the faculty possessed by the elements of living matter to move themselves in order to form species, and to do this without dependence on the properties of any structure;* (3.) *promorphosis*, or faculty of giving to amorphous elements a form determined beforehand, and conformable with the type of the species." An "unconscious faculty of feeling" is not intelligible: a faculty or facility, for the words are the same in origin and meaning, can be neither conscious nor unconscious, and an unconscious feeling is no feeling at all. In describing the second alleged property of every living thing there is equal confusion. What is meant by the "elements of living matter?" Are the atoms of oxygen, carbon, and so forth, declared to possess an automatic power, independent of the structure to which they belong, "to move themselves in order to form species"? "Impressibility" is affirmed to be "an attribute of life which exists in all tissues, which it animates independently of their textures." The physiologist does not know life apart from some living thing, and when a writer addresses us like M. Bouchut he is substituting metaphysical guess-work for scientific fact.

Life, as we know it, consists in actions that are obviously physical, and in operations that bear no analogy to any physical process. It is probably a complete mistake to represent life as controlling or resisting mechanical, chemical, or electrical forces. While an animal lives, its tissues are built up and taken to pieces according to a regulated method which is compatible with its continued existence, but all the physical operations of its life proceed in strict accordance with physical laws. If its albumen does not coagulate at a temperature that causes other albumen to undergo that change, it is not because a mysterious "principle" determines otherwise, but because the chemical conditions of coagulation exist in one case and not in the other. The power of maintaining heat is purely physical, and combustion follows the same laws in the body of the man as in the

* "En dehors de toute propriété de structure."

furnace of the locomotive. The power of resisting heat is equally physical, resulting from evaporation and other processes which experimental science can trace. When the body is dead, the amount and direction of the forces is altered, and then, of course, the changes that ensue are of a different kind. It is incorrect to say that no change has taken place except the escape or departure of an immaterial principle. The nerves no longer transmit, nor do the nerve centres generate, those physical forces that determine the actions of structure that is alive. Mr. Lionel Beale discovers a complete circuit in the nervous system, strengthening the analogy with phenomena of an electrical kind. Other physiologists trace a connection between the consumption of phosphorus and the amount of thought performed by the brain. Here we have two sorts of incidents, the connection of which no physical investigation can elucidate. The changes in the brain, and in the secretions, no doubt, follow chemical and other physical laws, and are simply the results of the direction and intensity of forces of the same character as those which preside over the material world. They thus form fitting subjects for the research of the physiologist. But when we arrive at the question of why thought is connected with a brain, and why changes in the condition of that brain precede or accompany mental manifestations, our inquiry belongs to a totally different sphere. No polarization of particles, or oxidation of phosphorus can help us here. The ultimate cause is the will of Deity; and if we seek for more we must do so in the direction of utility, and correspondence with that great scheme of creation, of which so small a part is unfolded to our gaze.

Let physical science give up the search for the *why*, and tell us *how* the universe proceeds. We start, and we conclude, with the conviction that an Intelligent and Benevolent Will is in all and over all, and in tracing the wonderful operation of what we call secondary causes, we exalt our conceptions of the only real Cause that animates and guides the mighty whole.

THE HISTORY OF THE SALMON.*

THE artificial breeding of fish affords an opportunity of resolving many interesting questions in the history of certain members of the finny tribes, as well as the means of augmenting the supply of food. It is now many years since Mr. Boccius introduced the system of pisciculture into this country, and although we are not able to affirm that salmon has become any cheaper in consequence of his exertions, there appears no reason why our most favourably situated rivers should not, once more, be well stocked with this much admired article of diet, or why ponds should not abound, in which humbler species of edible fish might be reared as a profitable article of trade. As neighbourhoods become populous, and a host of manufacturers settle down on the banks of romantic streams, it will become impossible to enforce any system of preservation, or to prevent the pollution of the water with some material inimical to piscine life. There will, however, remain for many years comparatively secluded streams in which a very moderate expenditure of capital would ensure a large and remunerative stock of fish.

The Stormontfield experiment is only a small one, but it has nevertheless led to important results. The scene of its operations is on the Tay, about five miles from Perth. Three hundred hatching boxes are arranged in parallel rows, with a walk or path between each. "The boxes are filled to within an inch or two of the top, first with a layer of fine gravel, next with one of coarser gravel, and lastly with stones as large as road metal." Before being put into the boxes, the deposits are freely exposed to sun and air to kill the larvæ of water insects that are very destructive to the fish, and currents of clean water from a filtering pond are allowed to flow freely through the apparatus when it is arranged. All being ready, a pair of salmon are captured to supply the spawn and the milt. The ova of the female are discharged in a tub by a suitable pressure and stroking motion of the hand. The milt is added in a similar way, and the water agitated to bring the two into contact. The impregnated spawn is then removed to the propagating boxes, and Mr. Brown tells us that the salmon colour of the ova is noticeably brightened when the milt comes into contact with them. This process goes on pretty quickly, so that in an experiment which began on the 23rd November, 1853, 300,000 ova were deposited in the 300 boxes in the course of

* *The Natural History of the Salmon, as ascertained by the Recent Experiments in the Artificial Spawning and Hatching of the Ova for Rearing of the Fry at Stormontfield, on the Tay.* By William Brown, Secretary to the Literary and Antiquarian Society of Perth. Murray and Son, Glasgow; Paton and Ritchie, Edinburgh; Hall, Virtue, and Co. London.

a month. To settle the question of whether impregnation took place before or after the female deposited her spawn, Mr. Buist had one box filled with eggs to which no milt had been artificially applied, but not one of them hatched, although a similar batch to which the milt had been added soon produced a goodly supply of young.

The following account of the hatching process will be read with much interest, although, to many of our readers, from the numerous accounts that have appeared from time to time in the papers, the information may not be new. Mr. Brown informs us that "on the 31st March, 1854, the first ovum was observed to have hatched, which was 128 days from the deposition of the first, and ninety-eight days from the deposition of the last of the ova. A high or low temperature of the water will accelerate or retard the hatching; ova have been hatched by us in sixty days in a constant temperature of forty-four degrees, but in the rivers of this latitude from 100 to 140 is the time, according to the season. We were furnished with a few ova, and by keeping up a supply of pure water, we were gratified by observing the little creature bursting the shell. The fish lies in the shell, coiled round in the form of a bow, and the greatest strain being at the back, it is the first part that is freed, and after a few struggles the shell is entirely thrown off with a jerk. The appearance of this fish at this stage is very interesting; what is to be the future fish is a mere line, the head and eyes large, the latter very prominent. Along the belly of the fish, from the gills, is suspended a bag of large dimensions in proportion to the size of the fish. This bag contains a yolk which nourishes the fish for six weeks, after which they must be fed." When this bag is absorbed, the young salmon becomes a "fingerling," or parr, from an inch and a half to two inches long. The young parrs are permitted to enjoy themselves in a pond, and are regularly regaled with boiled liver of the ox or sheep ground small. Upon this diet they thrive, and in about a year reach the size of the parrs found in the river.

In 1855 the first migration of the Stormontfield "smoults" took place. "On the 19th May, Mr. Buist, becoming convinced that the fry had become smoults, *i. e.* had taken on the silvery scales, caused a great many to be marked by cutting off the dead, or second dorsal fin, and turning them into the river." The sluice was drawn, but they showed no desire to depart till tho 24th May, when a large shoal went off. "On the 7th July, 1855, the first marked grilse was caught returning from the sea, at a fishing station near the mouth of the river Earn, a tributary adjoining the Tay, a little below Perth. This grilse weighed three pounds, which was a large growth in so short a time, "as the weight of a smoult before it reaches the tidal

wave is from one to two ounces." With reference to the time at which the character of the fish is changed, Mr. Brown informs us that one half go off the first year, and the other half remain in the pond; and, he adds, "until the parr takes on the smoult scales, it shows no inclination to leave the freshwater. It cannot live in saltwater. This fact was put to the test by placing some parrs in saltwater, and immediately on being immersed in it, the fish appeared distressed, the fins standing stiff out, the parr marks becoming a brilliant ultramarine colour, and the belly and sides of a bright orange. The water was often renewed, but they all died, the last that died living merely five hours." When the parr is covered with new scales it is ready for sea bathing. When it "returns as a grilse, its scales came off with the slightest handling, and it is only when it returns as a salmon, or has been long enough in the sea, that the scales become rigid and firm."

Among the various experiments in marking the fish to recognize them at a future period, silver rings were employed, but the individuals thus decorated appeared peculiarly attractive to their enemies, and the method failed. Mr. Brown contends that the success at Stormontfield justifies operations on a much larger scale, and it appears that Mr. Ashworth and his brother are making extensive experiments in Galway.

Among the natural history facts established at Stormontfield, we may mention, the proof that the parr is not a distinct fish, but the young of another fish, the salmon parr being the young of the salmon. It also appears that "the male parr is as fit to continue its species as the adult male salmon, but no female parr has yet been discovered with the roe developed." Among the fry that assume the migratory dress during the first year, the two sexes figure in nearly equal proportions, but why some remain behind for another year has not been ascertained. "That the smoults return again to the river in which they were reared has also been proved by the number of marked grilse which have been caught in the Tay since the experiment commenced. The experiment has also proved that the marked grilse of one year return as salmon the next, and we think it has also proved that all the smoults of one year do not return the same year as grilse, the one half returning the next spring and summer as small salmon."

We have selected from Mr. Brown's work—all the more valuable because the information is carefully condensed—a few points of general interest; but we recommend all who are specially concerned, to consult its pages, as it contains a clear exposition of a subject of considerable economical importance, and throws much light upon many scientific questions in the history of the fish about which it treats.

THE ELM AND ITS INSECT ENEMIES.

BY SHIRLEY HIBBERD.

In a paper entitled "Insects Injurious to the Elm," by Mr. H. Noel Humphreys, which has appeared in this work (August, 1862, p. 28), mention is made in somewhat approving terms of M. Robert's proposal to disbark elm-trees, in order to recover them from the diseases alleged to be caused by the attacks of insects. Observations extending over many years, varied occasionally by direct experiments, have convinced me that the elm enjoys an almost total immunity from the attacks of insects, and that, therefore, the accusations made against Scolytus destructor and Cossonus linearis are entirely unfounded, or rather have their foundation in a misconception of the facts. When so able a writer as Mr. Humphreys espouses Robertism, there is danger to be apprehended, and to avert that danger, I assert, in the first place, that neither Scolytus nor Cossus ever injure healthy trees, and that if they did so, the system of M. Robert would be more likely to hasten their death than their recovery. Mr. Humphreys has so truthfully and explicitly described the insects themselves, and their modes of boring and tunnelling in the tree, that there will be no occasion to refer to that part of the subject, except to point out the sources of error in the application of the facts.

It may be as well to state that there is nothing new in the hypothesis which assigns the death of elm-trees to the ravages of xylophagous insects.

There has been much written on this subject, and in nearly every case the writers have adopted arguments similar to those used by Mr. Humphreys, who, so far, is perfectly orthodox in concluding that as these insects are found in diseased elms, that therefore they are the cause of the disease. In the *Edinburgh Philosophical Journal*, 1824, is an account by Mr. M'Leay of the decay of elms in St. James's Park, in which he attributes their destruction to Scolytus. In *Curtis's Illustrations of British Entomology*, No. 11, is an admirable figure of Scolytus destructor, with a description in which the allegation of its destruction of elm-trees is repeated. In 1827 there was published in the *Cambridge Chronicle* (November 9), an account by Mr. Deck, of the decay of some elms in the front of Catharina Hall, in which he said—"their death has been decidedly occasioned by the ravages of a small beetle of the genus Scolytus, and of the species emphatically termed 'destructor.'" An admirably written reply to this, by Mr. J. Denson of Waterbeach, appeared in the *Magazine of Natural History*, 1830.

The journals of more recent date abound with notices on the same subject, and the discussion was reopened by a leading article in the *Times* newspaper of the 30th January, 1862, wherein the *procédé Robert* was cautiously advocated as "worth a trial" in this country.

That Scolytus destructor does bore through the bark of the elm and feed on the alburnum is not to be disputed. But let it be observed that the perforations are made in June and July, when the sap is in full circulation, and any small wound in a healthy tree heals over in the course of a few days. Let a healthy tree be then selected and bored with an instrument, so as to imitate as nearly as possible the action of the beetle. The experiment may be made still more complete by inserting in the borings some small shot or beads, in the same way as the insects deposit their eggs. In the course of a week or less it will be impossible to find those artificial perforations unless the part of the tree where they were made was marked for the purpose, and when the marks are examined, it will be found that the sap has deposited new material sufficient to close the perforations; so that if, instead of shot or beads, real eggs of Scolytus had been inserted, those eggs would be hermetically sealed up, and nothing but a miracle would save the larvæ from perishing. I believe it can be proved to demonstration that the race of Scolytus destructor would be exterminated in one season were the female beetles so misguided in their instincts as to deposit their eggs in healthy elm-trees; the power of vegetation would annihilate the brood by investing every cluster with vegetable tissue so dense as to cause their suffocation, even if the eggs were hatched, and that event would probably be as impossible as for the larvæ to eat their way either in or out. But elm-trees die, and are found on examination to be freely mined by these insects, yet they attest in their death that the insects were not the cause of death, and another experiment will explain it. Cut down a healthy elm, and the next season the root will throw up a forest of suckers. Ring a healthy tree, and unless it can form a new junction by granular extension of the edges of the bark on both sides of the ring, and on the upper edge especially, the same thing will happen; in fact, a healthy tree will refuse to be extinguished unless assaulted above and below, and it is reasonable to conclude that if an army of Scolytus, Cossonus, and Cossus were to commence their ravages in a tree previously in full vigour, the diminished vigour of the head would cause the roots to make efforts at once to replace the head with strong shoots from the roots. But when trees are found in a state of decay, and apparently owing to the ravages of these insects, there is such an absence of suckers and offshoots, that in *that* respect they

differ as much from healthy trees of the same species as in their general decrepitude of stem and branch.

But suppose we should for the moment grant that these insects sow the first seeds of dissolution in the life of the tree, will the *procédé* Robert recover them? In attempting an answer to this question we might discourse at considerable length on vegetable physiology, but there is no occasion, for the simple reason that we could say nothing new. M. Robert is said to strip the trees of their bark entirely, "the scolytus and cossuses are instantaneously annihilated, the trees throw out new layers of liber and even increase in bulk more rapidly than their mutilated contemporaries."—(*Times*, January 30, 1862.) If this is a correct account of the process, M. Robert is bold enough to strip the trees down to the *cambium layer*, which would no doubt clear away scolytes, leave cossuses untouched, and cause the death of the trees the same season. But we are very much of opinion that M. Robert has been misrepresented. In two letters addressed to us on the subject by M. Robert, he repudiates the idea of stripping a tree of its whole thickness of bark, and admits that such an operation must be followed by speedy death. He says, moreover, that he proceeds cautiously in removing vermin from the outer bark, and at the same time endeavours to *renew the roots* of the affected trees in order to promote a free flow of sap and a more active vegetation. More than this, M. Robert denies that he has had anything to do with those wretched elms that are to be seen in some of the avenues of Paris, tied with haybands, splintered up with barrel staves, and variously sliced and chopped about as if elaborately operated upon by means of a knife and fork.*

We may come now to a more reasonable view of the case. M. Robert is said to have recovered thousands of trees. But this has not been done by "flaying" them. He removes the outer layers of corky bark, which are often wholly occupied with colonies of insects. The removal of these may be of no immediate benefit to the tree, but the scraping away of the rough external bark without hurting the liber, to say nothing of penetrating to the cambium layer, has the effect of quickening the flow of the sap and improving the health of the tree, and

* "Les principales objections qui sont faites à mon système de traitement des arbres (scarified elm-trees), reposent sur une fausse interprétation. Il est évident, que si j'enlevais l'écorce d'un arbre dans toute son épaisseur, ou jusqu'au bois, dans l'espérance de le sauver, je justifierais la comparaison: 'An operation not much less bold in its own way than that of flaying a human being.' Le remède seroit, à coup sûr, pire que le mal. Mais ce n'est pas ainsi que je procède: je laisse, par un procédé qui m'est propre, assez de tissu cortical pour prévenir l'accident qu'on semble redouter, tout en détruisant avec certitude les larves ou vers qui toute l'écorce renferme, et cela, progressivement, pendant la guérison de l'arbre."—*Extract from a letter from M. Robert to the writer of this paper.*

if the roots are aided by new soil and suitable nourishment, no doubt the trees are benefited, and by the same processes every good gardener would follow to reinvigorate old orchard trees covered with rugged bark.

But for this to be necessary, presupposes a state of disease or debility in the trees operated on. This cannot be caused by Scolytus, which, as we have shown, not only does not, but cannot, attack a tree in full health and vigour. The tree first exhausts the soil in which it is growing, or some circumstance renders that soil no longer suitable for it. It begins to languish; the beetle then discovers that it is a suitable prey, and plays the part of *scavenger*, which is its proper office in the scheme of nature. To Scolytus has been assigned the task of eating up *dying* elm-trees; it never attacks a dead tree, never attacks a healthy tree, but riots in the elm when its reparative powers have already received a shock, and it is passing from life to death by atrophy. The appearance of Scolytus is a *sign* only that the tree has passed its heyday, then it may be possible to recover it by judicious treatment of the roots, and the removal of the epiphlæum, or corky layer; but to leave the roots alone and strip it to the cambium, will be but to hasten the process which has begun already, and with which Scolytus has had nothing at all to do. In a grove of elms, one here and there will be found infested with Scolytus, but the rest are untouched. Did Scolytus originate the diseased condition, all would be attacked alike, but it selects those that are in such a languid state, that when pierced for the deposition of eggs, they are unable to close up the small wound and entomb the larva in a mass of vegetable cells. There is one more proof for those who will observe for themselves, and draw conclusions from facts only. Whenever elm-trees seem to be decaying, it will be found that there is a pavement, or a hard pathway, or a drain, or something else over or near their roots, which prevents those roots exercising their nutritive functions in a normal manner. The elm roots near the surface; it likes a strong loam and plenty of moisture, and free access of air to its root fibres. When these conditions do not exist, or where, having existed, some change of circumstances has taken place, the trees will sooner or later decline in health, and when the process of internal decay has commenced, the insects peculiar to the elm take possession, and make a speedy finish of their work. The prudent forester will lay the axe at the root of an elm the moment he finds Scolytus in it, and take warning from the fact that the conditions of the soil are such that other elms must follow, unless, as M. Robert remarks, some attention be paid to the roots as the source of nourishment to the tree.

SPIRANTHES AUTUMNALIS,

NEOTTIA SPIRALIS, or *Ladies' Tresses.*

BY L. LANE CLARKE.

SCARCELY perceptible to the careless eye is the modest beauty of this little orchid, the last of its family that will unfold for us this year the "Manuscript of God" concerning the orchis tribe.

Deeply interested as all intelligent readers must be in Darwin's delightful book, for the facts he has recorded, the study of the British orchids will henceforth be an ever-recurring recreation to the observant eye.

First, in the early spring, the purple orchis mascula, and last, in the autumn time, this little white Neottia will again and again recall the wonder with which we first learnt the mysterious fertilization of orchids.

Of the three thousand species Lindley has numbered, most varied and fantastic in form are the exotics; but scarcely less curious are the spider, the bee, the fly, and the butterfly orchids of our own woods and meadows, and a minute examination of those which haunt our path will surely be acceptable to the intelligent observer.

The Spiranthes autumnalis is now abundant in dry pastures; it is thickly dotted on the Malvern hills, on the light pastures of the Isle of Wight, and the meadows and cliffs of the Channel Islands.

The spiral cluster of small white flowers is so insignificant in appearance, that more than once I have heard the exclamation of—"*That* an orchid?" Even so—gather one, and come and see.

It will require a microscope to discern all its beauty; but a pocket lens will show us much, and we shall learn from this one specimen what it is quite necessary thoroughly to understand, before we can appreciate the discoveries of Darwin.

The flower spike (fig. 1) is given natural size. The other figures are all more or less magnified.

In the single flower (fig. 2) we observe the plan upon which all orchids are fashioned, the number *three* ruling the plant, however modified by the Creator, "for whose pleasure they are, and were created." Three sepals, three petals, three pistils, and twice three stamens. These are not discernible at first, because the large lower petal, or labellum, is so prominent, and two upper petals are joined together, and one of the sepals adheres to them so closely as to require particular attention.

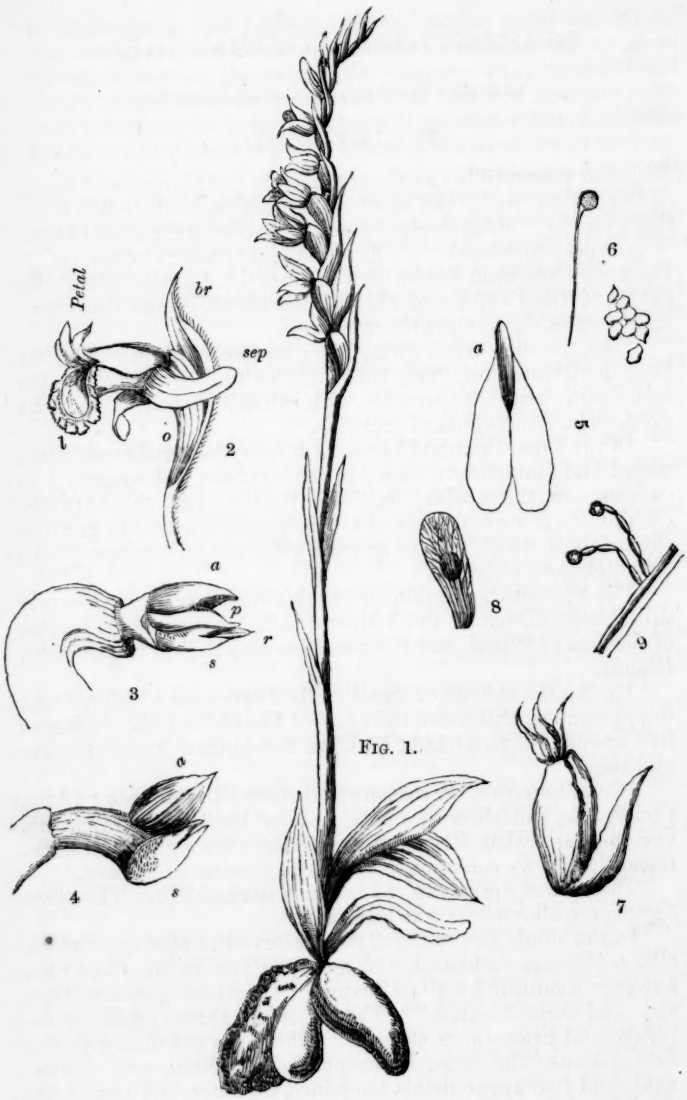


FIG. 1.

SPIRANTHES AUTUMNALIS.

Of the three pistils, one is modified into a rostellum or beak, *r*; the other two are confluent, and form a cup, the surface of which is the stigma. This stigmatic surface, *s*, like all other stigmas, becomes at a particular moment highly viscid, attracting and retaining the pollen grains, which throw their granular tubes down the loosened tissue, to fructify the ovules in the ovary beneath, *o*.

Six stamens, according to Lindley and Hooker, are discoverable in the perfect orchis; only one fertile anther is apparent in Spiranthes, which now demands close attention.

In examining a young Neottia with a pocket lens, and looking into the flower, we observe two pale yellow spots in the throat; these are the pollen masses or pollinia lying under the anther cell, *a*, and immediately over the stigma, *s*, attached to the rostellum, *r*, by a boat-shaped disk, in such a position as to render it highly improbable that the pollen grains of that flower can ever touch their own stigma. If a needle is passed into the flower, and this disk touched lightly, it will detach itself, and with it the whole pollinia, as in fig. 5.

This, on being pressed between thin glass under the microscope, will show the square or oblong pollen grains (fig. 6); or if applied to the stigmatic surface of an *older* flower, these bright golden grains will adhere to the glistening green cup, and be a beautiful object under a low power.

Some flowers, if stripped of sepals and petals, as in fig. 4, will show the anther cell empty, the stigma untouched, the flower unfructified—where, then, is the pollinia?

This is Darwin's discovery, that Spiranthes, like so many of its brethren, is indebted to insect visitors for the perfecting of its seed, depending also on the movement of its labellum, which at one period closes the throat, and protects the young stigma until its hour of maturity has arrived, then drops slowly down, opening its honey glands to invite the wandering bee, which bears upon its proboscis the pollinia previously extracted from a younger flower.

Resting on the sunny hills above Torquay, Darwin watched the intercourse between insect and flower. The little Neottia giving forth a sweet perfume to attract the living "winged things;" he saw the humble bee, as I have seen the hovering Syrphidæ and Tipulæ, and small Hymenoptera enter the flower cup; but these only entered one flower, and then flew away, I know not whither. Whereas he saw the bee always alight at the bottom of the spike, and, climbing up regularly, withdraw the pollinia from the upper and youngest flower, then fly to a next plant, rest for a moment on the labellum, which is moved aside, and whilst the insect sipped the nectar, the pollen mass was received by the expectant stigma. Then again mounting

the spike, as the long and flexible proboscis was thrust into the scarcely opened flower, it could not fail to touch the sensitive rostellum, and bear away the disk and its pollinia.

The experiment is easily tried, and you will find that once fertilized the stigma becomes dry, and will receive no more pollen. There is no waste in any of the works of God.

For more minute details of rostellum and disk, we must refer to Darwin's work, as the length of this paper is limited; but I wish to observe that a section of the ovary is well worth looking at, also the seeds, like pretty netted purses, which contain the germ of the future plant, fig. 8. A portion of the cuticle also, from any part of the stem or flower, will show jointed and glandular hairs, giving a crystallized appearance to the surface of these parts.

Fig. 7 is a mature ovary, with the withered sepals on its apex and the bract at its base.

COMET II. 1862.

BY THE REV. T. W. WEBB, F.R.A.S.

After the magnificent plume of the "Donati," and the brilliant nucleus and wonderfully extended train of our visitant of last year, "Comet II. 1862" has possessed comparatively little claim to general attention; and even in the telescope several of the more interesting features of these most unintelligible bodies have been absent: but in such as have developed themselves, there has been much of an instructive character. There has been no well-marked separation of envelopes in the head, no dark channel like a shadow in the tail; but the emission of luminous matter towards the sun, and the librating or swinging motion discovered by Bessel in Halley's comet in 1835 have been so unequivocal as to be eminently worthy of study. My attention was early directed to these points, and in the following pages will be found such observations as our vapour-loaded skies have permitted, and the capacity of a $5\frac{1}{2}$ inch object-glass has put within my reach. They may probably not be found in entire agreement with those made by other hands, and under other circumstances; and the student must be prepared for greater uncertainty in these matters than might have been anticipated. It is well known to all who have compared the records of cometary phenomena how variously their appearance is given by different instruments and observers; and

1.
Aug. 18.
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when even the comparatively well-marked features of Donati's Comet have met with discordant delineation at the hands of such men as Struve, Bond, Secchi, Lassell, Dawes, and De La Rue, it cannot, in fairness, be expected that any set of representations should be found in perfect agreement with others, especially under unequal circumstances as to optical power and transparency of atmosphere.

My first observation was on

August 14, in strong moonlight; when the nucleus had the aspect of a small star, with powers of 55 and 170, but became diffuse with 460. The coma was unequally distributed around it, being accumulated towards the sun; in this direction a dim and ill-defined brush of light issued from the nucleus, which was not effaced with 460. The tail, which was short and faint, issued chiefly from the left (inverted) side of the coma, giving an irregular aspect to the head, as though the axis of greatest brightness made an angle of 30° or 40° with that of the tail.

August 18. A clear night, but tremulous definition. The comet is a noble object in the comet eye-piece, power 27. The extent of the coma is very indefinite, but from a comparison with the diameter of the field may be put down at 15′. The tail can be traced with this eye-piece about $3\frac{1}{3}°$, it rises from little more than one-half, or perhaps two-thirds of the coma, on the left inverted, or diurnally preceding, or orbitally following side; towards which side its edge is sensibly concave, as well as brightest and best defined. Its breadth at its origin may be 10′; at a distance of 1° from the nucleus, about 22′. Its structure is streaky some way from the head, but there is no central darkness. Nucleus stellar with 55, 82, and 110; 170 begins to show a hazy border; 460 confuses it; its diameter may be estimated, very uncertainly, 1″ or 2″. A ray issues from it to the left, not centrally or directly, but with a kind of twist at its origin, the nucleus being in a line with its lower (inverted) edge; so that we have a kind of reduced copy of the whole comet in its own interior. 27 shows this ray, but it is much more distinct with 55 and 82, and is still evident with 170 and even 460. No clearly marked trace of an envelope, but something like a feeble sector of light, best seen with 27: the direction of the right side of the tail being assumed as 0°, its commencement may be fancied about 150°: thence it seems to advance, as to the vertex of a parabola, towards the sun; receding on the other side, it encounters the ray at about 210°, and is merged in the general light of the coma somewhere near 270°. All this is exceedingly indistinct; but it is more evident that there is a difference of hue, giving a particoloured and patchy aspect to the head; the nucleus and ray being

yellowish, the whole coma, but especially the sector, pale greenish-blue. The extent of the ray may be one-fifth of the radius of the coma. One micrometrical measure of position of tho ray, about 13h. gives 280°: at 10h. it had been estimated larger, perhaps 290°, but this was probably an illusion. Fig. 1 is a rough sketch of the head.

August 21. Haze and clouds: but in an interval comet well seen with 27 and 55. The whole is brighter; the sector more distinct and defined, especially to the left: the ray seems, however, somewhat less distinguished from the sector, and more divergent: measurement frustrated by gathering haze; but I believe the position is much the same.

August 22. A night of such great transparency and fine definition that the *comes* of 110 Herculis is pretty steadily visible. There has been a remarkable change. The nucleus is very small and faint, and, as it were, dissolved; barely star-like even with 27, and fading more and more with intermediate powers up to 460. The ray has become a kind of feather, slightly curved, concave to the inverted right, having the nucleus at the quill end, and expanding at the other to about one-fourth of its length. Its position at 11h. is, by one measure taken along the chord of its general curve, 250°, by a second, 249°·5; the agreement being, of course, accidental in so nebulous an object. The nucleus seems to melt away into the feather, which springs directly and centrally out of it. The sector of last night is much altered; anything beyond 27 is too high for the details of the coma; but it seems of feebler light beyond the end of the feather towards the sun, while a slight increase of brightness flanks either side of the feather, but is much more distinct and extensive on the left, on which side, however, the light seems to be indented by a kind of little bay or inlet, between the end of the feather, and the furthest advance of the light towards the sun. This brighter area, which may be an enlargement of the left side of the sector of August 18th, extends back towards the tail, till it reaches a very indistinct boundary, possibly a portion of a parabola in which the nucleus may stand, making an angle of perhaps 150° with the direction of the feather; the area is terminated on the left by a distinct, though not defined, set-off of light, not effaced with 55, 110, or even 170, which appears to form one side of a parabolic envelope; a narrow dark channel is suspected beyond it, but cannot be verified. The haze exterior to this set-off is suddenly and uniformly fainter; on the opposite side of the head nothing of the kind can be traced. The nucleus and feather are yellow, the surrounding light greenish-blue; but I think the contrast less marked than on August 18th. The diameter of the head is about 17′, but extremely indefinite. The tail is now divided

by a darker interior space, much lighter, however, than the sky; the separation commencing some way behind the head, and becoming more distinct in its progress. The right inverted branch is much the longer, narrower, and better defined, reaching certainly at least $3\frac{1}{2}^{\circ}$, and possibly considerably further; it seems concave to the right, not so perceptibly as before in any one field, but decidedly in the whole length (as to this, however, I have subsequently become uncertain, from noting the deceptive effect of the motion of an equatorial mounting, placed very far out of the meridian). The left branch of the tail is short, broad, comparatively faint, very ill-defined, and not extending more than $1\frac{1}{4}^{\circ}$ from the nucleus. As far as its light is tolerably distinct, it would seem, with the intervening darker space, to complete the perspective of a hollow structure, but beyond its termination, the other branch streams onwards so distinctly defined on both sides, and insulated on the dark sky, as to preclude any other supposition than that of separate existence; it is here 7′ or 8′ broad, and does not expand at all in its progress; the definition of its edges is remarkable. The coma is generally less luminous on the side turned from the sun, but there is no dark interval for a considerable distance behind the nucleus, and the origin of the tail is confused; the right branch seems to point to the nucleus and the brighter area to the left of it, as far as the set-off; the left branch appears to be a continuation of the left side of the coma, exterior to this boundary; so that the origin of the central darkness might possibly be referred to the dark channel supposed to adjoin this set-off, could its existence be verified; this, however, is doubtful, as the region behind the head is filled with confused haze. The passage of the nucleus near several small stars is very striking. Micrometrical measures of *distance* cannot be taken, in the absence of an illuminating apparatus; and an attempt at estimation is subsequently found in error; but fig. 2 gives something of the general effect.

August 23. Very clear night. Another great change: the nucleus has become strikingly more brilliant, but not stellar, being undistinguishable from the commencement of a luminous arc, shorter, narrower at the further end, and less curved than the "feather" of last night, but of so sharp and vivid a light, especially towards the nucleus, as to bear distinctly every power even up to 460. With a beautiful microscopic eye-piece by Powell and Leland, power somewhere about 300, the nucleus could just, though barely, be distinguished at its end; it is very minute, and cannot exceed 1″. The wider extremity of the arc is less abruptly terminated than that of the feather; its direction is obviously quite changed, and either the feather has retrograded through a considerable space, or

has faded and been replaced by a fresh emission at another angle; the only reason for the latter supposition is that, in the position occupied by the feather last night, there is a cloud, very slightly more luminous than the surrounding coma, in which a similar form may be traced; this is visible with a moderate power, but with 27 it extends further, and reaches down to the arc, so as to recall the feeble sector of August 18th, of which the faint cloud may form the most luminous part. It is possible that the nucleus may lie at the vertex, or in the course, of a parabola of haze, of which the left side may be traced in the drawing of last night, but this is uncertain; the set-off in the coma has faded so as to be barely perceptible: the colours in the head continue unchanged. The tail has closed up again so that the darker interior is filled in, and the whole looks narrower; the longer side is now much best defined on its right or external edge, the other being diffused in comparison; it may be readily followed with the comet eye-piece through $3\frac{1}{2}°$, and, precariously, as far again; both with this power and the finder it is seen to enlarge for some distance behind the head, and subsequently to taper off to a thin stream; its general aspect in the finder is straight. Position of chord of luminous arc, measured about 10h. 5m. G.M.T. gives 279°; a little later, 280°; about 10h. 35m. 281°·5. Fig. 3 is a sketch of the head.

August 25. Much cirrous haze, and the comet, though evidently much brighter than heretofore, is probably never quite clear. Another great change is shown with 27. The bright arc has totally disappeared, not a trace of it remaining with any power; and the feather has returned, in its previous form and position, being (9h. 15m.) the only perceptible feature in the head; it is, however, longer than before, and with greater proportional breadth, about one-third of its length, and much less distinguished from the coma, which may possibly be condensing towards the centre of the head. The nucleus is so exceedingly faint as barely to be made out with any eye-piece, the feather being only a trifle brighter at the quill end, which, like the other end, is broader than on August 22nd. 460 shows that either extremity is brighter than the centre; the broad end seems to occupy the exact position of the faint cloud of August 23rd. The edges of the feather are far less sharp than on August 22nd, nor do I think this, or the feebleness of the nucleus, chiefly due to our atmosphere, as the head is very brilliant, both with the comet eye-piece and to the naked eye. Measurement defeated by clouds, but position of chord of feather at 11h. 10m. guessed, very roughly, about 240°. See fig. 4, which represents only the centre of the head.

August 27. Sky very hazy. Nucleus not distinguishable

from the commencement of the feather with any power, from 27 to 460. The jet itself is straight in its brightest part, but there is a faint effusion from it to the right, towards the end, where it is less vivid. 8h. 48m. position by a single, but careful measure, 240°. It has made a near appulse, a few minutes before, to a considerable star. 9h. 15m, I can make out the arrangement of the coma better in a darker sky with 82, and the impression of August 9th is revived, that the axis of luminosity makes a considerable angle with the axis of figure, or that the nucleus may lie some way to the left of the vertex of a very indistinct parabola of light. There seems to be a feeble indication of a renewal of the" set-off" or envelope. See fig. 5.

August 28. Much cloud and haze, but the comet conspicuous in occasional clear openings. Feather very striking with 27; having returned to the appearance of the 25th: it is, however, decidedly a good deal longer, with the same proportionate width; more curved, and less sharply defined, than before; the centre being a very little fainter than either end; a feeble branch from the nucleus towards the left beneath, suspected with lower powers, is confirmed with about 300. Nucleus very dim, even allowing for haze, barely visible with 27; sharp and stellar, but very minute, with 55 and 110; with 170 confused, and probably elongated in the direction of the feather. The general aspect is greatly altered since last night: the nucleus was then the almost undistinguishable source of a vehement emission of light; now, it floats, an exhausted speck, in the end of a great cloud, with which its connection might be thought merely accidental; 27 shows a slight darkness to the left of the end of the feather, in the axis of the general structure, recalling the observation of August 22nd. The colours and magnitude of the head remain unchanged, but the tail is much altered; there is little difference in the finder, but in the comet eye-piece it is much more divergent, spreading over 25′ to 35′, 1° behind the nucleus; the two sides are very unlike; the right is still for a short distance the better defined and stronger, resembling the edge of a hollow structure, but there is nothing corresponding on the other side, which is feeble and diffuse, and there is no appearance of central obscurity. For 1° or more, the right side is somewhat convex, but it grows rapidly faint, and is soon blunted or rounded off towards the axis; further on, the old straight narrow stripe may be traced, and presumably in its original position, but it is now much more feeble; it may reach 4° or 5°, but its length is quite uncertain, as is a suspicion that it may be on the whole concave. What, however, is undoubted, and very remarkable, is that the brighter side at its origin is no longer directed towards the nucleus, or

near it, but much further outwards; it seems, in fact, to be one branch of a parabola, whose vertex lies exterior to the feather, though much within the coma next the sun, and corresponding, perhaps, on the other side, with the line of the old set-off, of which, however, no trace remains. Measurement impracticable from clouds, but position of chord of feather estimated about 250°. See figs. 6 and 7, the latter on a much smaller scale.

A succession of cloudy weather unfortunately terminated this series of observations at a time when they possessed the greatest interest, from the combination of a recent perihelion passage, subsequent to which the sun's influence is found to attain its maximum upon comets, with the nearest approach to the earth. Some remarks and deductions, aided by comparison with the more valuable observations of others, are reserved for a future opportunity.

Our readers will not fail to take every opportunity of studying the phenomena of Mars; the snows of his S. pole, and the curious configurations of his surface.

Only two occultations are visible at Greenwich during the month of October, and those at inconvenient hours.

OBSERVATIONS ON COMET II. 1862.

BY THE HON. MRS. WARD.

THE second comet discovered in this year* has passed into southern skies, having, while yet above our horizon, faded away from unassisted sight. It made its nearest approach to the sun on August 23rd, and to the earth on August 30th, having been visible to the naked eye—visible, that is to say, where the state of the weather admitted of any heavenly body being observed, from about the 1st of August.

Those who viewed it on one of the calm clear evenings between the 23rd and 30th of that month may have seen it, much as in our Plate, at a conspicuous height in the heavens, the broad pale head seeming somewhat to surpass in size any of the larger fixed stars in its neighbourhood, but to yield in brightness to many of the smaller ones, while the tail, transparent and filmy, scarcely as evident as any part of the Milky Way, almost faded from view as one gazed at it, and seemed best recognized by slightly averting the eye. Yet no one could for an instant glance at the starry heavens, and fail to see it was there.

Such, I think, is a fair description of Comet II. The cir-

* Comet I. was discovered by M. Schmidt on July 2nd, and for a few days was faintly visible to the naked eye.

cumstances under which it was observed were favourable rather than the contrary. It remained during nearly a month in that part of the heavens where the stars, as viewed in our latitudes, do not set, from their nearness to the Pole; it came, not in the twilight nights of midsummer, but at a time when five hours of real darkness could be reckoned on; and above all,

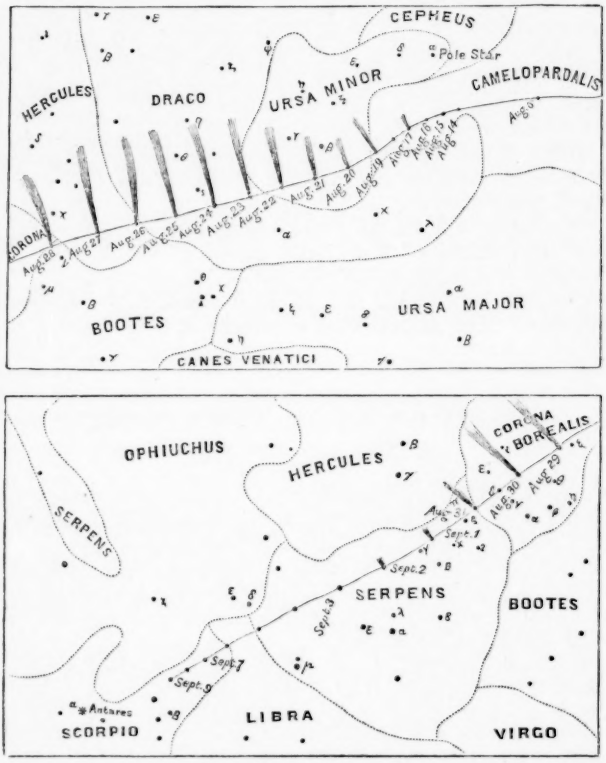

FIG. 1.—Plan of the Apparent Path of the Comet during nearly the whole time in which it has been visible.

the moon was absent during the greater part of the comet's best fortnight.

But I doubt not that many an intelligent circle of observers have felt somewhat discontented with Comet II. They have emerged from the more genial glare of a moderateur lamp "to see the comet," and, baffled in attempts to view its lofty position from a window, have scanned it out-of-doors, and I fear

have agreed among themselves that it was "not worth the trouble of looking after." May we arrest some such party of observers, and ask them to pursue the subject of comets with us during a few pages? till perhaps the general interest of the theme may lead them to reconsider their verdict, and welcome every comet for the opportunities which it affords for the elucidation of problems interesting from their very difficulty.

The comet which we have just seen, has come, as all conspicuous comets, with one remarkable exception—Halley's Comet—have come, unexpectedly, and unforetold. It was discovered, independently, by at least three observers,* about the third week in July, as a faint, hazy comet, discernible only in the telescope. In the same manner, Comet V. of 1858, better known as "Donati's Comet," was discovered. Others have escaped notice till detected with the naked eye. No sooner however is a comet seen, than the work of prediction begins. The comet is subjected to a most rigorous inquiry. The elements of its orbit are roughly calculated, and improved as observations accumulate, by a multitude of ardent and expert computers. Old records are ransacked, and old observations put into tangible shape, so as to rescue from oblivion the orbits of ancient comets which present any similarity to that of the new visitor.† Then, the comet's probable changes of apparent position and brightness for several weeks to come are estimated, with a degree of minuteness which might well lead the uninstructed to suppose that the stranger must have been confidently expected for a long period.

Halley's, as we have said, is the one conspicuous comet which was really expected. Its appearance in 1758 had been foretold by Halley many years before. It came punctually, and was again promised for the year 1835. Those who remember the announcement of its approach in the almanacs which came out at the end of the year 1834, and who subsequently saw the comet in the following October, are likely to have obtained a strong impression of the degree of regularity to be found among the movements of these strange wanderers. Nor is Halley's the only comet which has been observed to return, although no other visible to the naked eye has done so. There are six comets, visible in the telescope, and known as the "comets of short period," which have several times returned at the calculated dates, and again retreated from view. They are remarkable for the smallness of their orbits which, notwithstanding their elliptical shape, are entirely included in

* These were Mr. Tuttle, at Cambridge, in America, on July 18th, MM. Toussaint and Pacinotti at Florence, on July 22nd, and M. Rosa at Rome on July 25th.

† Herschel's *Outlines of Astronomy*, art. 597.

that of Neptune. The period of these six comets vary from about three years and a quarter—that of the comet known as Encke's—to seven years and a hundred and sixty-three days, that of Faye's Comet. The probable returns of other comets have been foretold, but the day of fulfilment, in many cases, is far away; centuries, or even thousands of years hence.

Is then so little known, it may be asked, about each comet which appears? Have they not then the interest which belongs to the planets as known and established denizens of the solar system? Rather say they have a very special interest of another kind.

A comet—speaking in a general way—is composed of head and tail. There is a large ill-defined mass of light called the head, which is usually much brighter towards its centre, offering the appearance of a vivid *nucleus* like a star or planet. "From the head," I quote Sir John Herschel, "and in a direction opposite to that in which the sun is situated from the comet, appear to diverge two streams of light, which grow broader and more diffused at a distance from the head," and these commonly uniting into one mass of filmy light, and extending to an immense distance, form the comet's tail. This is not a matter of seeming. It is not merely that the brightness fades away from the region of the nucleus to that of the tail; *the nucleus forms the tail,* and subsequently retains a control over it, and this, says Mr. Bond, in his valuable account of Donati's Comet, "is one of the most curious phenomena presented in nature."

When a comet approaches that part of its parabolic or elliptical path which brings it nearest to the sun, some extraordinary phenomena begin to be observed in the region surrounding its nucleus. The nucleus (sometimes becoming suddenly brighter than before) throws out a jet of light *towards the sun,* which jet, though bright at its point of emanation from the nucleus, fades rapidly away, and becomes diffused as it expands into the "coma," or head. Another and another jet succeeds; and each, while expanding in the coma, curves backwards, as if impelled by a force of great intensity directed from the sun. And thus the comet's tail is formed. These strange phenomena, though observed in the cases of the great comet of 1811 and of some others, were first noted with minute attention by the illustrious Bessel in the case of Halley's Comet in 1835. The very night on which these wonders first manifested themselves was also signalized by the commencement of the tail of that comet. It is impossible (says Professor Grant) to doubt that this appendage derived its origin from the nebulous matter which had been in the first instance raised from the head by a force directed to the sun, and was subsequently impelled by a powerful force in the opposite direction.

Again, in the case of Donati's Comet, the nucleus, about a fortnight before the day of its nearest approach to the sun, might be plainly observed to throw out faint rays of light towards that luminary. At Rome, on September 16th, 1858, M. Rosa (one of the discoverers of Comet II.) observed *two* divergent streams of light shot out from the nucleus of Donati's Comet. These proceeded for a short distance towards the front of the coma, then abruptly turned backwards and streamed into the tail; and M. Rosa compared them to long hair when brushed upwards from the forehead, and then allowed to fall on each side of the head. Six days later they had given place to a fan-like bright sector (or semicircular disc of light). On the 27th, this "fan" appeared more spread out. On the 30th, the fan still continuing, a new set of phenomena began to appear. A succession of luminous hoods or "envelopes" were observed, like canopies over the nucleus from which they had been emitted, and these too ultimately streamed back into the tail.

The reader must not suppose that this streaming motion was visible to the eye. Taking into consideration the great distance of the comet, a movement of a thousand miles a day (such as, for instance, was observed in one of those strange "envelopes" of light) could not be detected as motion, though sufficiently evident in its effects. Thus Bessel, watching Halley's Comet, with unremitting attention during one long night in October, from sunset to sunrise, was rewarded by seeing a jet from the nucleus describe in that time an arc of thirty-six degrees; and Bond was able to observe the germs of the "envelopes" at the surface of the nucleus, and to trace them through successive stages to their full development.

Such changes, then, varying in detail, but bearing a considerable general resemblance in all bright comets which have been closely watched with the telescope, go on before the eyes of astronomers; but meanwhile, the cause of them remains a profound mystery; nay, more, they are seemingly in defiance (says Mr. Bond) of the best established properties of matter, the laws of gravitation and inertia. Here he speaks of the developments observable in the comet's own physical structure. With regard to the motion of comets in space, *there* the laws of gravitation do hold good; but, strange to say, it is the *nucleus* alone which moves in obedience to the attractive force of the sun and planets. "Immense volumes of matter," continues Mr. Bond, "apparently of the identical substance of the nucleus, go to compose the enveloping nebulosity and the tail, but from the moment of leaving the central body, their motion is perfectly inexplicable, without assuming them to be under the influence of laws of force, which greatly modify that of gravitation."

But I pause, for I fear the younger members of the party who have so patiently listened to the tale of "enveloping nebulosity," "gravitation," and "inertia," may tire of the recital. Shall we try a lighter strain,—a sort of short-hand or bird's-eye view of the subject?

Here, let us say, is a comet. Let us take Halley's Comet; for although possibly some of our other celebrated comets have come just as punctually, there were no Halleys or Newtons two or three thousand years ago to predict them. Here, then, is a comet which has obeyed the sun during seventy-five long years, coming back at last, and showing becoming deference on its way to Jupiter and Saturn, by lingering a little as it passed them by; here it comes, steadily and solemnly, when lo! a jet of light, apparently similar to itself, darts forward with force sufficient to overcome the motion which it must have had as a part of the comet's small, hard heart; strange enough, but stranger still, it soon tends backward, in opposition to both its original pace and its newly achieved outburst. Backward it streams, with what enormous force, and to how extraordinary a length! A comet—I could give name and date—emitted a tail sixty million miles long in two days; and the same comet brandished said tail in the manner of a straight and rigid rod, right round half a circle, in the space of two hours! in defiance of all received laws. It was *seen to do it;* eyes were not deceived, for the eyes of Newton saw it, and similar feats have been recorded since his time on the part of successive comets.

So, as we gaze after little Comet II. and wish it a long farewell, we say to it, with half-admiring perplexity, "You belong to a strange family; in part you obey our laws, and in part you are influenced by quite a different code—shall we ever understand you better?"

And not far from such thoughts are more solemn feelings, of deepest reverence for Him unto whom all his works are known, from the beginning of the world—who sees beautiful order where our limited senses seem to behold confusion, and who reigns supreme alike over the army of heaven and among the inhabitants of the earth.

I shall now trace the story of Comet II., so far as observations have hitherto been reported to me. Discovered first in Europe, July 22nd, it appears to have been concealed from the view of astronomers by adverse weather till near the end of the month, when Mr. Romberg observed it at Leyton, near London; its appearance through the telescope being that of a round nebula, strongly condensed in the centre.* On August 1st he observed the tail; Mr. Crumplen also saw it at Euston

* Letters to the *Times*.

Road, noting a dark appearance down its centre, and estimating its length at about a degree and a half. On the same evening M. Bulard saw it at Algiers, and M. Littrow at Vienna. On August 3rd it was viewed by various astronomers, among them Mr. Dawes, who was struck with the remarkable distinctness of the nucleus.* He noted that on the side farthest from the sun its edge was hard and sharp, but that on the side next the sun "a condensed stream of nebulous matter issued from the nucleus, gradually expanding itself, and at length falling back on all sides, and becoming mingled with the general coma of the head." "The whole appearance," he adds, "strongly reminded me of a fountain, ascending to a moderate height, and then falling over on all sides in fine spray."

Fig. 2, though belonging to August 15th, seems well to illustrate this description. It represents the comet as seen in an inverting telescope. The jet of light is also noticed by the other observers on August 3rd. On the 5th, Mr. Dawes observed similar phenomena; but truly remarks that about this time the sky usually presented an aspect more like December than August. Nevertheless, a few notes were made on the 7th by other astronomers. Professor Challis observed an approach to the form of a sector in the bright central portion of the coma, and he noted that the right border of the comet's tail seemed brightest when seen in the telescope.

FIG. 2.

Mr. Howlett, F.R.A.S. (to whose kindness I am indebted for the figures which illustrate this part of the narrative, as well as for much information concerning the comet), first saw it on the 14th, and took the above sketch on the 15th, at nine P.M. On the early morning of the same day, Mr. Hind estimated the comet's brightness to the naked eye, as being about equal to Gamma in Ursa Minor, and the tail three degrees in length.

Meanwhile, I had enjoyed no single view of the comet. For a whole fortnight I had vainly watched to see even a single star winking through my large staircase-window. But late on the 17th, a starlight night came at last; I then, to make up for past disappointments, watched the comet carefully from midnight till half-past one. I knew where to look, from the calculations which had appeared in the *Times*, and at once saw the "woolly appearance" which had been familiar to my eyes in the case of the great comet of 1861, in its last days of feeble visibility. I could not see the tail with any certainty till I viewed it with the telescope; then it became visible, but not to

* *London Review*, August 16th.

any great distance from the head. The whole head was decidedly brighter than the tail, and I noticed a remarkably round effect in its shape, and also that in some way the comet's eastern side was somewhat better defined than the western. I imagined a sort of curve in the comet's general shape, but the whole object was so faint that I could not define what its form might be.

I saw it next on the morning of August 20th, at four o'clock, but only to observe it fade in the daylight shortly after the disappearance of Eta in Ursa Minor; again, however, in the evening I saw it well on a black sky, its tail now tolerably visible, though short, and through the telescope displaying a streaked and unequal appearance. I thought the head not so much brighter than the tail as it had appeared on the night of the 17th.

Meanwhile, some friends at Florence had observed it on the 16th. Even there, adverse weather had frequently concealed it from view, and when seen on the 16th, the tail was barely perceptible.

FIG. 3.

Mr. Howlett furnishes me with the annexed sketch of the comet (fig. 3), as observed on the 19th, accompanied by the following note:—"Observe the very strikingly *partial* method of the development of the comet's tail, which was almost exclusively confined to the eastward of the imaginary line joining the nucleus and Zeta Ursa Minoris, towards which I could trace it on the 19th instant, at eleven P.M., for eight degrees. At this time the preceding luminous jet appeared to me to form an angle of about 168 degrees with the general direction of the comet's tail." Mr. Howlett also remarks—"What a contrast the appearance and form of the comet presented, as drawn respectively on the 15th and 19th instant."

I should here perhaps explain that my reason for employing Mr. Howlett's drawings in preference to my own (which strongly resemble them), is, that the telescope which he employs, being three and a quarter inches aperture, brings out the delicate details of the comet with more completeness than I can expect from mine, which is an inch less in aperture; and his plan of drawing is likely to ensure much correctness. He does not make his sketches literally at the telescope, being impeded by the well-known obstacle in the way of representing faint objects by night, namely, the difficulty of seeing the object in the greater brightness of the lamp used to throw light on one's drawing. He first obtains a good general idea of the comet by carefully viewing it with an opera-glass or an eye-piece of thirty dia-

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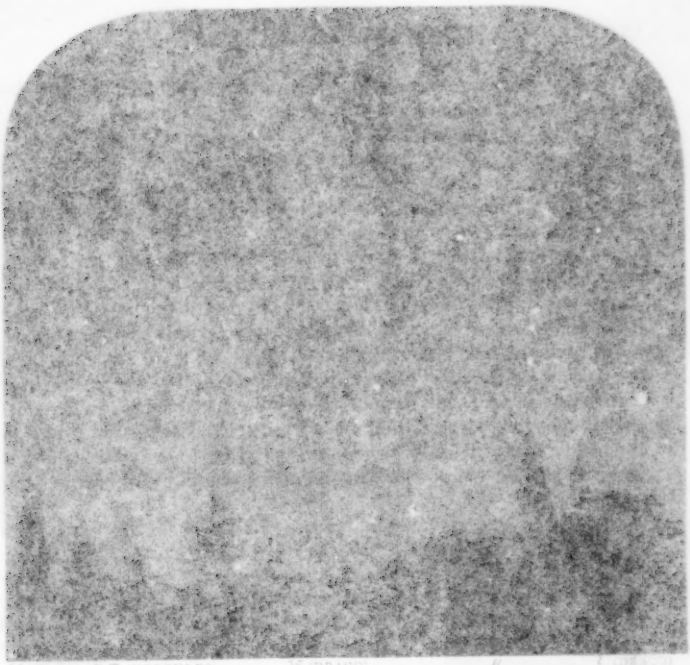

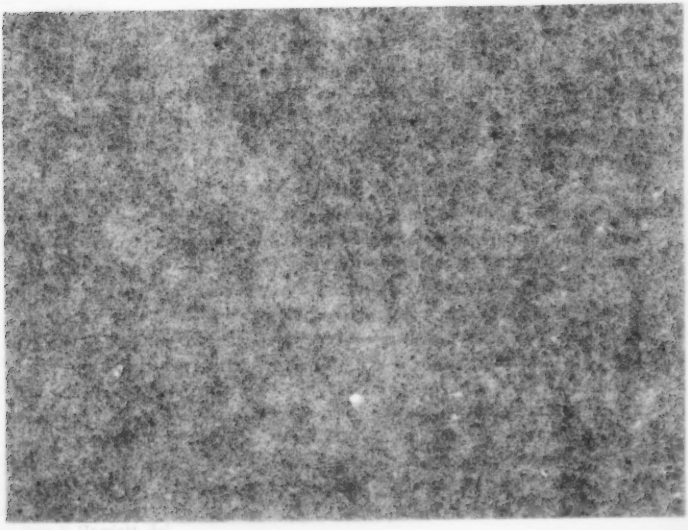

meters, to ascertain the direction of the tail, and also of the jet from the nucleus, and having carefully observed these particulars for about a quarter of an hour (the telescope being out of doors), Mr. Howlett, re-entering his house, marks them down by slightly scratching on black paper with a penknife, the paper being supported on a pane of glass, and held before a lamp, which renders the slightest scratch at once apparent. He then repairs to the telescope, applies a higher power, generally 120, and earnestly scans the comet till some new feature is fully impressed on his mind. Then he returns to the lamp, and very carefully notes down what he has seen. Sometimes ten minutes are employed in making sure of a fact, and as long a time in fitly representing it. Thus the drawing goes on till completed. Any scratch *de trop* is rectified by a little thick ink applied to obliterate it. These transparencies represent nearly the whole comet; but except in my tinted plate, I have copied only the head of each.

My own plan, though as different as might well be, I am inclined to think is also very efficient. I place my telescope on a table out of doors nearly opposite a window. Inside the window stands a lighted candle, and in front of it a powerful condensing lens (belonging to my microscope), placed at that precise distance from the candle that it casts a narrow stream of light to a great distance. I have a piece of card or paper and a pencil on my table, and when I choose I can place the paper in the brilliant light from the lens without allowing the glare to reach my eye. My drawings, being done in pencil, represent stars by black dots, and the brightest parts of the comet by the darkest shading, but I frequently copy them at once in imitation of the real appearance.

Perhaps the two plans could be combined, and the black paper and lamp conveyed to the open air; only that comets take us by surprise, and we hastily improvise a plan, instead of losing time by making many experiments.

On the 19th, Mr. Dawes also observed the comet, and notes that the nucleus was no longer so singularly sharp and distinct as on the 3rd. From this time, the weather appears to have improved, and many observations have reached me; but space permits me to give few besides my own and those of Mr. Howlett.

The comet, on the evening of the 21st, appeared to me as a conspicuous and beautiful object. The texture of the tail seemed streaky, as on the 20th, appearing like folds of the most delicate gauze. The nucleus and jet of light reminded me of the shape of a shuttlecock, the feathers turned to the right and sloping downwards, and surrounded by a bright glare of light. Its changed its aspect in a fitful manner, or at least appeared to me to do so. I do not know that this fitful appearance was

real, and not caused by weariness of the eye; I only know that nothing of the kind ever occurs when I am engaged in examining the nebula of Orion; and on this evening any fixed star which I observed continued sharp and unchanged as long as I looked at it.

This was the only occasion on which I observed either by the telescope, or with the naked eye, any momentary variation in the comet's appearance. Something of the kind, however, appears to have been occasionally observed by others. "All of us," writes my correspondent at Florence, "have remarked that the light of the tail varied, and seemed at moments to dart upwards in a stream from the nucleus, somewhat like an aurora on a small scale." Similar to this was an appearance observed at Versailles in the case of Donati's Comet, but strongly and vividly marked, like everything connected with that glorious phenomenon. The narrator, Dr. Montucci, states that, in September 1858, he, in company with another person, saw the comet suddenly fade away, tail, head, and nucleus—the nucleus disappearing a few seconds after the rest. For upwards of a minute (and this happened in clear weather), not the slightest vestige of the comet was visible, and then "the nucleus, so to say, caught fire again, and the superb tail shot out again in a blaze like a sky-rocket." This whole affair occupied about five minutes, and occurred five or six times in the same evening. It was also observed on subsequent evenings.* A similar phenomenon, as far as the disappearance of the tail goes, was observed on July 4th (by a correspondent of the *Morning Herald*), as occurring with the great comet of 1861.

Such appearances are referred to also by Mr. Hind in his treatise on *The Comets*. "There is," he says, "one singular appearance in the trains of great comets which we must not pass over in silence. It consists of apparent vibrations or coruscations, similar to the pulsations peculiar to the Aurora Borealis. These vibrations commence at the head, and appear to traverse the whole length of the tail in a few seconds of time. The cause was long supposed to be connected with the nature of the comet itself, but Olbers pointed out that such appearances could only be attributed to the effects of our own atmosphere." This kind of movement is recorded as having been observed in the tails of comets in 1607, 1618, 1652, and 1662, and, more recently, in that of 1769, and the great comet of 1843. Should another remarkable comet appear, the observation of this phenomenon would be an important employment for those who observe principally with the naked eye; and I would say to them, "You cannot view a comet too earnestly, too carefully. It hangs there, apparently an established

* From the *Comptes Rendus* of the Academy of Sciences.

ornament of the heavens, yet in how few days it will have gone away, and as far as you are concerned, for ever!"

On August 22nd, the comet showed well—I thought it curved decidedly; my idea was that the tail set out from the head as if to slope to the right, then suddenly bent to the left, and thenceforward was straight. Mr. Howlett also saw the comet well in England (fig 4). He makes the following note:—"On August 22nd the jet from the nucleus (the nucleus was very faint) appeared to me almost in a straight line with the tail. I did not observe anything of the fan-shaped appearance which it has since assumed. A pretty group of five stars from the seventh to ninth magnitude probably, was on that evening to be seen near the head of the comet. One of these, about 3′ 40″ to the eastward (following side) of the nucleus, was quite immersed in the coma, which just skirted upon two other small stars on its preceding margin. The tail, as seen here" (in Kent), "500 feet above the sea level, appeared about seven degrees in length."

Fig. 4.

Unfortunately, neither Mr. Howlett or I succeeded in seeing the comet on August 23rd. It would have been satisfactory to have been able to record its appearance on that evening, as it then gained its nearest point to the sun. Professor Challis saw it at Cambridge, but speaks of having found the night less favourable for observation than he could have wished.* Mr. Chambers, at Eastbourne, was more fortunate. He noted that the jet of light was inclined to the direction of the tail by an angle of about sixty degrees; and by five different measures he estimated the tail at twelve degrees in length.†

On August 24th Mr. Howlett obtained a fine view of the comet (see tinted Plate). He makes the following note:—"The nucleus had thrown out a very conspicuous and broadly fan-shaped jet. The west side was the most sharply defined, and seemed to me very nearly in a line with the general direction of the tail, which latter I could trace for about eight degrees in the direction of Eta Draconis. The coma appeared to me at this time to be cleft, as it were, or at least to exhibit a rather marked deficiency of luminosity in the north-east quadrant, which greatly enhanced the fan-shaped appearance of the jet." Mr. Chambers's note for the same evening is:—"The sector or jet of light has greatly increased in amplitude. It now covers fully 120° of a circle." The tail, he says, extends nearly or quite to Eta Draconis

* *London Review*, September 6th. † *English Churchman*, September 28th.

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His observations were made with an excellent refractor, aperture three inches, and powers employed from 21 to 120.

On August 25th, Mr. Howlett obtained another good view of the comet, fig. 5. He says:—"The deficiency (that is of luminosity in the N.E. quadrant) seemed to be filled up again, but the western edge of the jet was far from being in a right line with the general direction of the tail, forming with it, indeed, an angle of some 160° towards the west side."

On this evening I was able only to obtain a momentary glimpse of the comet between clouds; I had but time to note its position and to remark that it was very white and brilliant. But on the next evening (26th) I had my *best* view of it. I began to look for it while Arcturus and Vega only were *clearly* visible, and the Ursa Major stars to be made out with great difficulty. I could not, however, detect it till the latter were all bright, except Delta. Then the comet showed and decidedly brighter than Delta. It increased in brilliancy as evening advanced, and its tail seemed to reach as far as 16 in Draco (see tinted Plate). I thought it nearly as *large* as Donati's in the days immediately preceding September 30, 1858, but far from being as *bright*. It was more like the subdued light shown in the well-engraved view of the comet of 1819 in Herschel's *Treatise on Astronomy*. I thought the comet's tail of considerable breadth at its extremity, and was pretty sure of a decided line of light to the left.

Fig. 5.

My view through the telescope was not satisfactory, for the sky began to cloud over as I concluded my general scrutiny of the comet's appearance. The nucleus and jet of light seemed small and somewhat long.

On the 27th the sky was overcast here, but Mr. Howlett saw the comet clearly, and, as he afterwards told me, the tail on that evening appeared longest to him, namely, thirteen degrees. His drawing of the head, fig. 6, is accompanied by the following note:—"Some very pretty groups of minute stars were now to be seen involved in the tail and coma. One was about 4′ N.E. of the jet.

Fig. 6.

The tail, he says, "was *concave* on its orbital *preceding* side." He also thought it somewhat deflected at its extremity towards the north-east. His next view was on the 30th; but meanwhile I had seen the comet

to considerable advantage on the 28th and 29th. On the 28th the comet's head appeared to me to be large rather than bright. I could compare its apparent size (to the naked eye) with that of Alpha in the Northern Crown, but its degree of lustre with some far smaller star. I believed the tail to be of a broad and fan-like shape, and to extend as high as Eta in Hercules, but in excessive faintness. Very different in this respect from Donati's Comet, the curve of which I could compare, I remember, with one cut out in paper, and held over its brilliant "preceding margin," in rather close proximity to a candle.

In the telescope I noticed that the nucleus had no star-like appearance whatever, but with the jet presented the appearance merely of a long and cloudy patch of light. There were some picturesquely placed stars in the field of the telescope, to the left of the comet; and having noted their places accurately on paper, I was much surprised and interested to observe how rapidly the comet neared them. I had observed them first at about nine in the evening, noticed their change of place at ten, and had completed my notes of the comet's appearance more than an hour later, when it occurred to me to take out the telescope again, and ascertain how far the comet might have accomplished its transit across those stars. It had actually (at twelve P.M.) left the stars far to its right, and two bright stars which I had thought too far off to introduce in my first sketch were now below the comet, looking about as near it as the stars Eta and Zeta in Auriga do to the star Epsilon, as seen by the naked eye. On the 29th, though the evening was very fine, and all the sinuous windings of the Milky Way distinctly shown, I felt sure the comet was not so clearly visible as on the 26th, when any one could at once see its tail, even through a glass window. On this evening, though I put all candles and lamps out of sight, I failed to see it through that window otherwise than as a pale and rather large fixed star.

In the open air it was better, the tail showed faintly, and I still thought I saw a slightly more decided outline to its left than its right side. The telescopic view was rather good. The head stood out well from the black sky, and on this evening the nucleus was bright. I wished very much for a sight of it through the most suitable instrument possible. The roundness of the head was striking, and one could have almost supposed there was no tail,—that part of the comet being so much fainter than the head, and also somewhat narrower.

On the 30th, between drifting clouds, I caught sight of the comet, most picturesquely placed as a temporary ornament of the Northern Crown, and felt with what a new interest these passing comets invest our old familiar constellations.

Mr. Howlett's last transparency was made on this evening

(fig. 7). He thus describes the comet:—"The tail that evening appeared to me much more uniformly distributed, and the jet, which was now directed towards the western or preceding orbital side of the nucleus, was pretty sharply defined on the same western margin, but feathery on the eastern side, where, too, the coma was chiefly condensed."

Fig. 7.

Mr. Howlett quite corroborates my observation, that the comet had diminished in brilliancy and length of tail since the 26th and 27th. He observed it again on the 31st, but was not able to make a sketch of it. He could not trace the tail to a greater distance than three degrees.

No further observations have reached me; but I was myself able to view the comet on Sept. 1st, 2nd, 7th, and 9th. On the 1st, moonlight began to conceal it. The moon, however, set at ten o'clock, and I could then observe a very decided diminution in the comet's brightness. On the 2nd the moon did not set till after the comet had disappeared along with the stars of Serpens, behind some trees; and in the bright moonlight the comet had not seemed more than a round "woolly" star.

On the four following evenings the sky was overcast. On the 7th, a day before full moon, I had lost my account of the comet's probable place, but, nevertheless, gave myself a task to detect it. In one minute I found it out, and then made sure of it with the telescope. A yellow star was in the same field of view. The comet appeared small, and of a roundish shape, but not at all regularly circular. There was no visible nucleus, but a perceptible brightness about the centre; no tail whatever.

On September 9th I saw it for the last time.

There was very bright moonlight, in which even the stars Epsilon and Delta of Ophiuchus were not very readily visible. Trees hid Antares, but I could guess at its position, which with that of Beta (in Scorpio) helped me to ascertain the comet's probable situation. Long staring at the sky, I imagined a pale spot a little way north of Beta. On this I fixed my telescope, and very plainly saw the comet, faint and small on a light grey sky; yet there was a look of some importance in its aspect, giving one the idea, that had moonlight been absent its tail would still have been visible.

I looked long at it; the ideas of retreat, disappearance, and a long parting impressing themselves very vividly on my imagination as I removed the telescope, leaving Comet II. to pursue its long mysterious journey.

P.S.—Sept. 18th. Two days after my concluding observation of the comet, namely, on September 11th, my friend at Florence had an interview with M. Toussaint of the Observatory there, who, with M. Pacinotto, had been a discoverer of Comet II. M. Toussaint kindly lent for my benefit three bulletins received by him from M. Chacornac, of the Paris Observatory, saying that they contained a full statement of particulars relating to Comet II. M. Toussaint added, verbally, the following remarks; that he had observed two branches in the comet's tail, the right (when viewed without inversion) being shortest. Fig. 8, copied from his diagram, shows the relative lengths of the two sides of the tail. Fig. 9 represents merely the head of the comet, as sketched by him to illustrate his description of its telescopic appearance, showing the nucleus, the flame which projects towards the sun, and the surrounding vapour.

Fig. 8.

Fig. 9.

The report of M. Chacornac will, doubtless, be read with interest. He was one of the most successful observers of Donati's Comet, having frequently watched that remarkable object from the time of its rising, after midnight, till daylight rendered it invisible. I should mention, that in my translation I have always employed the word "aigrette" where he has used it, and that the word "jet" is also transcribed without alteration. With this short preface, I commend to the readers of the Intellectual Observer these bulletins from Paris, which have certainly reached their new destination by a somewhat circuitous route—*via* Italy and Ireland.

APPEARANCE OF COMET II. AT PARIS.

NOTE FROM M. CHACORNAC.

THE second comet of this year, now visible near the Pole, presented to view, on the morning of the 10th and 11th of August, a luminous aigrette, analogous to that which was observed in Halley's Comet at the time of its last appearance. The sector was much more brilliant than the rest of the nebulosity, and turned towards the sun. Its amplitude was forty-six degrees at three on the morning of the 10th; on the 11th, at ten minutes past two in the morning, the amplitude proved to be sixty-five degrees. Thus this sector widened, like that of Halley's Comet, as the nucleus approached the sun.

Besides this alteration, which might be compared to the expansion of the corolla of a convolvolus, the eastern branch of the sector which, on the morning of the 10th, was the most extended and brilliant, and which measured an arc of forty-five seconds, exhibited only a rudimentary form on the morning of the 11th. The western ray, on the contrary, became developed, and subtended an angle of sixty-three seconds, and its brightness surpassed that of the eastern ray.

On the 10th, the nucleus presented the aspect of a fusee ("d'une fusée"), that is to say, it had a much longer diameter in the direction of the radius vector than in that of the perpendicular. The proportion of these two diameters was as one to three. I had not hitherto observed the nuclei of comets to be lengthened in this direction. The great comet of 1858, and that of 1861, both exhibited the contrary phenomenon; the lesser diameter of their nuclei were towards the direction of the radius vector.

On the 11th, this aspect had much diminished, and the two diameters of the comet's nucleus approached equality. No certain trace of polarized light was visible in the nucleus; and still less could it be detected in the light of the sector.

In short, the appearance of luminous expansion in the form of an aigrette directed towards the sun, presented by Halley's Comet, and which had already been observed by Heinsius in the head of the comet of 1744, are not exceptions peculiar to the nature of those comets. The great comet of 1858, that of 1861, and even the last comet of short period which has appeared, have presented luminous expansions, which I have observed, and which may be compared to a vaporous jet directed towards the sun, and forced to retreat by an action emanating from that luminary.

This comet, which now presents to the eye a brilliancy equal to that of a star of the fifth magnitude, and may be expected

to become ten times brighter, will probably offer appearances which will assist in the study of the physical constitution of these bodies.

SECOND NOTE FROM M. CHACORNAC, ON THE SECOND COMET OF 1862.

In continuing to describe the changes which have occurred in the present comet's head since the 10th of August, it may be said that four distinct aigrettes have become disengaged from the nucleus by a succession of phenomena, analogous to those which were seen in Donati's Comet at the time of the disengagement of its envelopes.

When a new aigrette is about to be developed, the nucleus of the present comet assumes an elongated form, in the direction of the radius vector, and its extremity, turned towards the sun, is terminated by a feeble tuft, ("houppe") which gives it the aspect of a burning torch. Some hours later, the nucleus extends in the same direction, and the part facing the sun becomes more diffused in enlarging. Next day, a long ray, which may be compared to those observed around the sun at the moment of a total eclipse, may be seen turned towards that luminary, but no longer following the direction of the radius vector; it deviates therefrom by a certain angle, opposed to the proper movement of the comet. Other rays, of about half the size, visible on each side of that first mentioned, complete the aigrette. The nucleus, then, is seen as a clearly-defined luminous centre, occupying the apex of the cone formed by the aigrette. These objects being sufficiently well-marked in outline, can be perceived through the vast nebulosity which envelops them; and from this nebulosity escape feeble particles of cometary matter, which go to form the tail, in the direction opposite to the sun.

Later, the outlines of the rays and of the aigrette become less clear, and the principal ray continues to be inclined on the axis of the tail in a direction opposed to the movement of the comet, in the same shape in which a flame is inflected when exposed to a current of air.

While thus inclining, the ray augments the amplitude of the aigrette. When it comes to form an angle of only about 100 degrees with the then direction of the tail, it is extremely diffused, enlarges along with the aigrette, and their much-weakened light becomes confounded at the borders with that of the nebulosity. Then the nucleus again becomes oval; a new ray, a new aigrette are prepared to pass successively through a set of phases similar to those we have just described.

Thus, from the 12th to the 17th of August, we have seen three rays and three aigrettes detached from the nucleus.

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To give an idea of these luminous expansions turned towards the sun, we may state, that the principal ray measured on the 17th, towards eleven o'clock in the evening, an angle of two minutes. That is to say, it extended beyond the nucleus over a space four times greater than the diameter of the earth.

On the same evening, the comet presented to the eye the appearance of a nebulous star, of a brightness nearly equal to that of the star Gamma in the constellation of the Little Bear. Nevertheless, the tail, on account of its dimness, could scarcely be distinguished to the length of a degree.

THIRD NOTE FROM M. CHACORNAC ON THE SECOND COMET OF 1862.

THE comet continues to present interesting phases in the development of its aigrettes.

In attentively following the form of the jets which escape intermittently, I have just remarked a fact still more strange than those described in the preceding notes. In the latter I pointed out that one of these jets or rays, darted firstly in the direction of the sun, was afterwards turned aside in a direction opposed to the movement of the comet, so that on the next day it could be observed making an angle with the direction of the previous day ("avec la direction de la veille").

The fine weather which has lately come having permitted me to follow during whole nights the mode of transformation of different vaporous jets which have been disengaged from the nucleus, I will recount the phenomena in the true order of their succession.

Firstly, it is necessary to say, that the ray of the previous day, directed nearly to the sun, was not that which one saw next day inflected in a direction opposite to the movement of the comet; the latter was a new ray emitted by the nucleus in this very direction.

From the 17th to the 20th of August, pondering on the forms presented by the rays, alternately rectilinear and clear, or curved and diffused, I already felt doubtful of the identity of these two jets; but, following the opinion of Bessel about Halley's Comet, I believed in some analogous movement of the aigrette of the present comet, all its other phenomena seeming to confirm this analogy.

Three nights in which the sky was completely overcast, left me in this belief. On the 22nd of August, the sky having again become clear, I persevered from nine in the evening till four next morning in following the slightest variations perceptible in a jet directed to the sun, and I believe I have detected its true nature.

In the night from the 25th to the 26th of August, having

been able to repeat the observation on another jet which I also saw again on the evening of the same day, I give a summary which will truly interpret the phenomena. ("Voici sommairement quelle serait la véritable interprétation des phénomènes.")

The nucleus of the comet emits in the direction of the sun a vaporous jet, whence seem to escape particles of cometary matter as a jet of steam escapes from a machine. This jet preserves, during a certain time, a rectilinear form, which seems to indicate a considerable force of projection emanating from the nucleus. Soon afterwards it bends slightly, and presents the appearance of a curved cone, bearing much resemblance to a horn of plenty, as usually represented. At this time the gaseous particles accumulate at that extremity of the jet nearest to the sun, under the form of rounded clouds; and this appearance seems to indicate that at this distance from the nucleus the force of projection is conquered by a resistance which is opposed to it.

Some hours later, this luminous jet takes a diffused aspect, and shows that the nucleal emission has ceased to go forth in this direction. At the moment when it commences to change its form, and at an angle of position inclined about thirty degrees towards the east, the first traces of a new ray may be seen, its development presenting the same phenomena as those which preceded it. Sixteen hours later, in the direction of those first traces visible on the previous day, may now be observed a new ray, and this latter continuing in this interval of time to lose shape ("se déformer"), appears dispersed in the hemispherical envelope like a fog, scarcely preserving any traces of its original form and direction.

In its successive transformations this new ray offers in the sequel the same appearances as that parallel to the radius vector.

Since the epoch of the comet's perihelion passage, the jet which nearly corresponded to the radius vector inclined gradually westward to that point to which the other ray tended on the 30th of August, precisely in the direction opposite to the tail of the comet.

APPLICATION OF DIALYSIS TO THE PRESERVATION OF BUILDING STONES.

THE discoveries of Mr. Graham regarding the process of dialysis were described in a paper by Mr. Tegetmeier in our last volume. The prognostic of the speedy application of the process to the useful arts has been rapidly verified in a practical application of very considerable interest.

The ease with which, by the aid of dialysis, solution of silica (flint) of almost any strength can now be prepared, has suggested its use as a cementing material for binding together the particles of porous and perishable stones, and other similar materials. This application was originally proposed by Mr. W. Crookes, but it has been found that there are some drawbacks to its employment. The flint solution, in many cases, gelatinizes on the surface of the stone, and, drying up, scales off, bringing with it the outer particles of the stone surface. Mr. A. H. Church, whose researches on the formation of certain silicious minerals we have already noticed in the INTELLECTUAL OBSERVER, has improved this process so as to obviate its defects. He attains this result by the use of a solution of baryta in the first place, the flint solution being applied afterwards; in some cases where the nature of the materials to be operated upon requires it, the order of application of these solutions is reversed. The effect of the completed process is very marked. Porous stones become almost non-absorbent; their hardness is greatly increased, and their liability to injury from atmospheric influences, almost, if not entirely, removed; brick, terra-cotta, and many other materials are likewise rendered nearly waterproof, while plaster of Paris casts are greatly improved in durability and appearance by this treatment.

The rationale of the process is very simple. The successive application of solutions of baryta and of silica causes the deposition within the substance of the stone of the insoluble and unalterable silicate of baryta; no soluble, and therefore unnecessary and injurious, salt being produced, as is the case in other processes for the preservation of stone from decay. Where, for instance, silicate of soda and chloride of barium are successively applied, not only is silicate of baryta formed, but also an equivalent proportion of chloride of sodium or common salt. By the washing out of this soluble compound by the action of rain, the continuity of the protective coating is impaired; and if the salt be not removed more serious consequences may ensue by its crystallization, deliquescence, or efflorescence.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ENTOMOLOGICAL SOCIETY.

NEW COLEOPTERA FROM COCHIN CHINA.—The discoveries of M. Mouhot in Cambodia and Cochin China were described at page 240 of our first volume, in the account of the meeting of the Geographical Society held March 10.

Since that date M. Mouhot has fallen a victim to his scientific exertions, a circumstance which gave a melancholy interest to the grand collection of Coleoptera, many new to science, which he had obtained from the mountains of Lao, in Cochin China, and which were exhibited by Mr. Stevens. Mr. A. Wallace exhibited a new and very admirable plan of mounting small Coleoptera and other insects on slips of thin transparent gelatine in the place of card; the advantages being twofold, firstly, that the use of gum is unnecessary, as the insect adheres firmly to the moistened gelatine; and, secondly, that the underside of the insect is readily examined, as the gelatine may be obtained in sheets which are perfectly transparent and colourless. This latter advantage is one of no slight importance in those cases where only single specimens of rare insects are contained in a collection.

On the same evening Mr. Smith exhibited a singular specimen of the common hive bee, *Apis Mellifica*. The head had the peculiar form and large eyes of the drone or male, and the legs and wings of the right side were also those of the drone.

The left side, however, was that of a neuter or common worker, whilst, as if to complete the singularity, the sting was straight, resembling that of the fertile female or queen bee.

INSECT FLYING UNDER WATER.—*September* 8. Mr. John Lubbock showed a small British Hymenopterous insect, not more than a line in breadth, which had been captured swimming under water by means of its wings. It had been determined to be one of the Ichneumons, the *Polynema fuscipes*. Little is known of the habits of this insect, and it is difficult to account for the circumstance of one of a parasitic group being found in such a situation. Mr. Lubbock had ascertained that it was able to live four hours under water without the necessity of coming to the surface to breathe, but that if a number were submerged for a longer period, as during a whole night, they were found dead in the morning. There was nothing in the external structure of the insect that would have suggested an aquatic habit had it been captured out of water. In those birds that fly under water, as the black Guillemot and common Razorbill, the wings are always very small in proportion to the size and weight of the birds, and have consequently to be used with great rapidity and without intermission when the animals are flying in the air.

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This shortness, however, renders them admirably fitted to a subaqueous mode of progression. In the *Polynema fuscipes*, however, the wings are of full size in proportion to the insect, a circumstance that renders its peculiar habits more remarkable.

GLEANINGS FROM THE INTERNATIONAL EXHIBITION.

Frog in Block of Coal.—We have much pleasure in stating, that the earnest protest we entered against the exhibition of this absurdity has had its desired effect. Shortly after the publication of our last number calling attention to it, a letter appeared in the *Times* signed P.; which was generally attributed to a most eminent Metallurgist and Professor at the Government School of Mines, repeating the objections we made. Since then others of an equally indignant character have been published. Whether the Commissioners who have so generally mismanaged the Exhibition would have removed the animal we are not aware; but the difficulty was suddenly brought to a conclusion by its death.

Live Animals in the Exhibition.—In the original announcement issued for the guidance of exhibitors it was distinctly stated that no live animals could be exhibited in the collection; without giving any notice to those exhibitors who wished to show the specimens of the new Ailanthus silkworm, Ligurian bees, and other domesticated insects, the Commissioners allowed a few exhibitors to show live animals, thus, two exhibitors of bee-hives were so favoured.

The frog above alluded was another exception; but, perhaps, the most useful animals in a living state are those contained in a glass in the Victoria court; we allude to the Australian medicinal leeches. These from their colour are obviously a distinct species from our officinal animal, and as they appear unusually hardy, having performed the voyage from Melbourne in distilled water, they might, perhaps, be successfully acclimatized in this country. Their hardihood may be judged from the fact, that only four out of a large number have died during nine months since they were captured in Victoria, and that since they have been in the Exhibition they have commenced breeding, having produced cocoons.

Delarue's Photographs of the Moon, and of the Great Solar Eclipse.—It may be in the recollection of many of our readers that a corps of astronomical observers amply provided with instruments visited Spain at the period of the great Solar Eclipse of 1860, in order to make and record observations during the passage of the Moon over the Sun's disk. Mr. Delarue, accompanied by a strong staff of photographic assistants was of the party; and the very large and valuable photographs showing the various phases of the eclipse are the results of his journey. All persons at all interested in astro-

nomical studies should avail themselves of the opportunity of inspecting these valuable records, which enable the most transient phases of the phenomenon to be studied with a degree of careful attention that would be impossible but for the aid of photography.

Development of the Human Body.—Dr. Liparzik exhibits a series of beautiful models by Francis Müller, illustrating the gradual development of the human figure from birth to adolescence. These models show the results of many thousand observations and movements, and are extremely valuable to physiologists, educators, and artists. In connection with this subject there should also be noticed the valuable series of models of Dr. Roth, shown in Class 29; these indicate how the normal development of the body may be most surely obtained by the aid of gymnastic actions, and apparatus designed to exercise each part. In addition to these valuable aids to healthy development, Dr. Roth exhibits specimens of shoes and other articles of clothing which do not produce deformity by exerting undue pressure on any part of the body. The hygienic value of these garments is very great.

Models of Buildings.—Amongst the more remarkable models of buildings in the Exhibition may be mentioned that of Lincoln Cathedral made nearly from 2,000,000 old corks by an agricultural labourer; though not made accurately to scale, this model is remarkable for its correctness, and is a good instance of the great amount of work that may be accomplished by persevering industry during leisure hours.

The model of the Cathedral of Milan in the transept is executed by a professional designer, and is accurately made to scale, being carved in soft wood; it is, perhaps, one of the most exquisitely finished models ever constructed, showing the exact character of even the smaller carvings in the original edifice.

Singing Machine in the Austrian Court.—The singing machine has not maintained the opinion that was expressed respecting it before its exhibition. It is not properly a singing or articulating instrument, but should rather be described as an organ with a vox humanus stop.

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NOTES AND MEMORANDA.

RAMSAY ON THE GLACIAL ORIGIN OF LAKES.—In a paper which will be found in the *Quarterly Journal of the Geological Society* for August, 1862, Professor Ramsay gives reasons for considering that the great Alpine lakes, such as Geneva, Zurich, Constance, Maggiore, Lugano, Como, and others, "do not lie among the strata in basins merely produced by disturbance of the rocks, but in hollows due to denuding agencies that operated long after the complicated foldings of the miocene and other strata were produced." He remarks that none of these lakes lie in simple sinclinal troughs, and that in no case of lakes among the Alps is it possible to affirm that we have a sinclinal hollow, of which the original uppermost beds remain. After showing the objections to various theories of the formation of the lake hollows, he observes, "Now, if the Lake of Geneva do not lie in a sinclinal trough, in an area of subsidence, in a line of fracture, nor in an area of mere aqueous erosion, we have only one other great moulding agency left, namely, that of ice." He then shows that "when at its largest, the great glacier of the Rhone debouched upon the miocene beds where the eastern end of the Lake of Geneva now lies." It was "about 2200 feet thick when it abutted upon the mountains, and when it first flowed out upon the plain at the mouth of the valley of the Rhone, the ice, according to Charpentier, must have been 2780 feet thick. Add to this the depth of the lake of 984 feet, and the total thickness of the ice must have been 3764 feet at what is now the eastern part of the lake." "I conceive, then," he adds, "that this enormous mass of ice, pushing first N.W., and then partly W., scooped out the hollow of the Lake of Geneva most deeply in its eastern part, opposite Lausanne, where the thickness and the weight of ice, and consequently its grinding power, were greatest." He applies similar reasoning to other Alpine lakes and to the great lakes of North America, also to lakes in Cumberland and Scotland, and elsewhere.

GEIKIE ON THE LAST ELEVATION OF CENTRAL SCOTLAND.—In the same journal, Archibald Geikie, Esq., of the Geological Survey, describes the evidence he has obtained, to show that a "portion of the coast of the Firth of Forth has been elevated not only within the human period, but even since the first years of the Roman occupation."

BURNING GUNPOWDER IN VACUO.—M. Bianchi lays before the French Academy his experiments on the combustion of gunpowder in a vacuum. He found that this substance, and also the fulminates, burnt quickly if loose in an exhausted vessel, and suddenly brought to a temperature exceeding 2000°. If, however, the powder was placed under similar circumstances in a pistol, it inflamed with the suddenness exhibited in the air. Gun cotton slowly disappeared, the layer nearest the source of heat going first, but without the production of any light. In all these cases the products of combustion were the same as in air. Combustion also took place in nitrogen, carbonic acid, and other gases which do not support it, and there was little diminution of the ordinary rapidity of the process.

CURE FOR HOOPING COUGH.—Dr. Joset states that infusion of wild thyme effects a cure in this troublesome complaint.

ARTESIAN WELLS IN THE DESERT OF ALGIERS.—*Cosmos* informs us that in five years terminating with 1859-60 fifty wells have been sunk in the Algerine Sahara, capable of yielding 36,761 litres of water per minute. 30,000 palms and 1000 fruit-trees have been planted. Numerous oases have been recovered from ruin, and two fresh villages established. The expense has not yet reached 298,000 francs, and has been covered by a slight additional tax, and by voluntary contributions from the Arabs. The water is slightly saline, and a little bitter from the presence of Epsom salts, but it is not found to be unwholesome.

THE CONSANGUINITY CONTROVERSY.—M. Beaudouin communicates to the French Academy an account of his "breeding in and in" with a flock of three hundred sheep without any apparent ill effect; but in this as in similar cases, the alliances between the two sexes were strictly regulated, and all weak and unde-

sirable animals were excluded. In one case, during a period of twenty-two years, a sheep was born in this flock exactly reproducing the primitive type. M. Beaudouin agrees in the main with M. Sanson, but observes that he generalises too fast when he says that the inconveniences attributed to consanguineous connections have no foundation in observation. "We should add," observes M. Beaudouin, "when such unions take place between selected individuals." M. Gourdon, after reviewing the proceedings of the most celebrated cattle-breeders, contends that Durham oxen, New Leicester pigs, Ditchley sheep, and other successful examples, are, however useful to man, monstrosities, constituted in opposition to all the laws of health, and that connections of consanguinity always produce mischief, although it may be convenient to resort to them for special purposes.

Temperature of Spheroidal Liquids.—In a paper sent to the French Academy, M. S. de Luca states as the result of his experiments on water in the spheroidal state, that the liquid in this condition does not wet the vessel which contains, and receives heat by radiation and by occasional and imperfect contact with its sides; this heat is employed in volatilizing the superficial layer of the liquid, and in producing a vapour by which the radiant heat is absorbed, and consequently the spheroidal liquid varies in temperature, being cooled in proportion as the evaporation goes on.

An Innocent Green.—The *Chemical News* gives the following, on the authority of the *Journal de Pharmacie*, as an innocent substitute for arsenite of copper in pastrycook's work. Infuse for twenty-four hours 0·32 grammes of saffron in 7 grammes distilled water. Then take 0·26 grammes of carmine of indigo, and infuse them in same manner in 15·6 grammes distilled water. Mix both liquids, and a beautiful green is obtained, 10 parts of which will colour 1000 parts of sugar. To preserve the colour evaporate the liquid to dryness, or convert it into a syrup.

A Powerful Fulminant.—Mr. J. Horsley, writing in *Chemical News*, states that three parts of ferricyanide of potash and four of chlorate, make a violent fulminant, which explodes on being rubbed with a hard substance. Too great caution cannot be employed in such experiments, and the quantities should be *very* small. Mr. Horsley gives a timely warning of the danger of exploding white gunpowder by friction, and he calls the mixture of equal parts of chlorate and red prussiate of potash "a treacherously powerful fulminant."

Alcohol from Coal-Gas.—We read in *Cosmos* the following description of a patent taken out by the Sieur Castex in December, 1854:—"In burning organic matter the smoke which is disengaged can be entirely absorbed by concentrated sulphuric acid. This sulphuric acid mingled with water, and distilled, yields alcohol. To facilitate the absorption of all the smoke of the organic matter, it is made to pass over a substance like coke, wetted with the sulphuric acid. Before sending out coal-gas it may be treated according to this method." M. Berthelot first mentioned to the Academy his synthetic mode of preparing alcohol in January 1855.

Professor Wyman on Infusoria.—The *American Journal of Science* gives the details of a number of experiments relating to the controversy concerning the generation of infusoria. Professor Wyman, apparently operating with great care, obtains results nearer those of Pouchet than of Pasteur. He boiled various infusions of animal and vegetable matter, and sealed them in flasks containing only air that had been exposed to a red heat. Nevertheless, in a number of instances, he obtained infusoria, usually Vibrio Spirillum and Bacterium, but sometimes ferment cells, monads, and kolped-like bodies. He cannot reconcile his results with the theory of the dissemination of eggs.

Dagron's Microphotographs.—The Abbé Moigno gives a most enthusiastic account of the new method of preparing and exhibiting microphotographs invented by M. Dagron. After describing a process by which a series of the minute sun pictures are taken in rapid succession, he proceeds to inform us that a number of "cylinders of common or flint glass are prepared in advance, about five or six millimetres long and two thick. The second extremity of these cylinders is spheri-

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cally rounded in a hollow, to transform it into a magnifying lens. To one extremity of the cylinder a microphotograph is fixed with Canada balsam, and the edges ground by an optical tool to efface the marks of the union. "This is the photomicrographic cylinder, one of the most delightful conquests of science and art. . . . If we look at the plane end of the cylinder we see the picture with great difficulty as a black almost imperceptible point, and M. Dagron was naturally led to do for the second extremity what he had done for the first. He fastened on a second picture with Canada balsam, he rounded the glass in another hollow, and he obtained a cylinder which twice performed the functions of microscope and object holder." In other cases he fixes the picture so that it can only be seen when the glass is held at a particular angle. As the originality of these methods was disputed, and their merit referred to Sir D. Brewster, who gave some similar hints, the Abbé Moigno obtained a letter from that philosopher vindicating M. Dagron's claims to the invention.

Claude Bernard on Vascular and Calorific Nerves.—In two papers, which will be found in *Comptes Rendus*, M. Bernard describes his "experimental researches on the vascular and calorific nerves of the Great Sympathetic," and thus states certain general conclusions to which he has arrived. "It seems to me proved that the vascular and calorific nerves are special motor nerves. Before mingling with the mixt nerves, these nerves constantly emanate from the ganglia of the Sympathetic, where they may be always found concentrated as in a kind of plexus. These nerves afterwards distribute themselves in a special and exclusive manner to the vessels, and cannot be replaced by ordinary nerves, since, as we have seen, the motor nerves which animate the fibres of a muscle, do not distribute themselves to these vessels. Moreover, as I shall hereafter show, the vascular and calorific nerves have special physiological properties, and special reactions upon chemical agents." In another place, he observes—"My experiments on the Great Sympathetic of the posterior and anterior limbs, as well as on that of the head, demonstrate that the vascular and calorific nerves are throughout topographically and physiologically independent of the muscular nerves properly so called; from whence arises this general proposition, that the vascular circulatory apparatus possesses a special vascular motive system, and that the movement of the blood can be accelerated or retarded in the vessels either locally or generally, without any participation of the nervous motor system belonging to muscular movements. The local and functional congestions that periodically occur in certain organs, are examples of this independence of the circulatory movements, and fever furnishes us with a striking pathological example."

Naudin on Hybrid Plants.—M. Ch. Naudin lays before the French Academy an account of his experiments with Datura Tatula and Stramonium. On crossing, he obtained plants which he calls Stramonio-tatula, and from the seeds of these he obtained offspring of the same sort. From these plants he took seed, and reared twenty-two fresh plants, of which five reproduced the characters of D. Stramonium, nine reproduced those of D. Tatula, and partially returned to the Tatula type, and six were nearer to it than to the hybrid type of the first generation.

Picrate of Aniline.—We are indebted to Mr. John G. Dale, F.C.S., of Church, near Acrington, for a specimen of this new and interesting substance, which is, as he observes, a very pretty object for the polariscope. He says: "I find the best way to crystallize, is that recommended by Mr. Davies of Warrington for his sulphate of copper and magnesia. I make first a cold saturated solution of the salt in alcohol as free from water as possible. Put a few drops on the slide, and dry it quickly over a spirit-lamp. You will by this means get a transparent varnish over the glass, from which the salt will crystallize in beautiful disks upon cooling. Sometimes the crystals do not appear with the first application, owing to the film being too thin; then it will be necessary to repeat the operation. The crystals should be kept from the air, as they soon get dark coloured." By following the above directions we have obtained beautiful results. Some of the disks have presented exquisite arborescent, rose forms very suggestive of ornamental designs. A pleasing effect is produced by revolving the polarizer, and the selenite stage may be used with advantage.

MR. GLAISHER'S BALLOON ASCENT.—The second scientific ascent of this year took place on September 5, and the descent was safely effected near Ludlow. The aeronauts passed through 2000 feet of cloud saturated with moisture, above which the air was clear. At three miles above the earth a pigeon was let loose, but could not fly, and dropped like a stone. Two others were similarly affected, but at four miles high a fourth managed to get to the top of the balloon. At five miles Mr. Glaisher felt symptoms of blindness, and the thermometer was 37° below the freezing point. He afterwards saw the barometer at ten inches, indicating 5¾ miles, but was unable to register it, and he shortly became unconscious. Mr. Coxwell retained his faculties, and ascended for another ten minutes, the aneroid indicating about six miles. Mr. Coxwell then felt faint, and his hands were powerless, so that he had to pull the valve with his teeth, and the balloon commenced its descent. At five miles the air was perfectly dry, and at the greatest elevation the temperature seemed as low as 44° below freezing, but Mr. Glaisher did not read the index until he was out of the car, and it may probably have been disturbed. As the balloon descended, Mr. Glaisher recovered, and recommenced his scientific labours, having reached a far greater height than was ever before attained.

A NEW APPLICATION OF THE THERMOMETER.—Every one accustomed to the use of the thermometer must be familiar with the fact that it gives no account of the effects of various temperatures, draughts, and damp upon the sensations. During the last great balloon ascent of Mr. Glaisher, a temperature of 17° was felt to be *warm*, because the voyagers had just quitted a region where the instrument registered some degrees below zero. So in leaving a room heated to 80° or 90°, a temperature of 60° will be felt to be cold. It is one of the advantages of the thermometer that it has no sensations, yet it would be an advantage if we could sometimes use it to measure the magnitude of those influences which affect sensation as to heat and cold, and the mode of so using it is very simple. A few years since Dr. Jonathan Osborne communicated to the British Association some experiments on the use of a *heated* thermometer as a means of instructing the physician as to the influence of climate on health, but the subject was neglected, and he has again called attention to it in an essay on the subject in the *Dublin Quarterly Journal of Medical Science*. One use of the heated thermometer is to explain the difference observed in the effect on invalids of climates having similar thermometrical characteristics. Thus the western coast of Ireland has a mild and genial climate if tested by the thermometer only, yet the trees are stunted in their growth by the constant wind blowing from the Atlantic, and invalids do not reap such advantages from a residence there as would be predicated by trusting to the thermometer only. So, during a severe frost, if the air is still, the cold is not much felt, but if there is a moderate breeze or a gale, even with a moderate rise of the thermometer, the sensation of cold is keenly felt, and, in point of fact, as regards health and comfort, the temperature is lower, though the thermometer says differently. In Petersburg, during the greatest severity of the winter, the drivers of public vehicles are bound to be at their stands, but if there is a wind, they may stay at home, for the cooling effect of wind might then prove fatal. The author thus describes the principle on which the use of the heated thermometer depends:—"The bulb being heated up to 90° Fahr., represents the heat of the surface of the human body; when in this state it is exposed to a cooler medium, whether air or water, or mixture of both as moist air, and allowed to cool to 80° Fahr., the time for cooling these ten degrees represents (inversely) the cooling power exerted by that medium, whatever it may be, or however applied. This cooling power is derived from other agencies besides difference of temperature, as from radiation of the neighbouring objects, conducting power of the surrounding medium, and more especially from currents causing various proportions of it to be brought into contact with the heated body within a given time. Now these agencies have their combined results exhibited in the degree of rapidity with which the cooling is effected. Placed, as we are, in a medium with few exceptions, always below 80°, we are constantly undergoing a process of cooling. In our ordinary clothing we feel just comfortable at 56° indoors; but when exposed to a current of air, even at the same temperature, we feel cold in proportion to the force of the current, or in proportion to the

conducting power imparted to it by increased moisture. Both these are agencies of which the thermometer takes no notice. Its indications are furnished by the contractions or expansions of a fluid, whether mercury or spirit, which always maintains the same temperature as the surrounding medium, and accommodates itself to these changes by altering its own density in the same proportion. The living animal, on the contrary, as always maintaining a temperature of its own, and as constantly resisting cooling agencies, is not to be considered as passively submitting, like the fluid of the thermometer in its ordinary state. When heated to 90° Fahr., that being nearly the temperature of the surface of our bodies—in the rapidity with which it is cooled, depending on the intensity of the cooling influences, it furnishes an index to their combined effect. It does not depict the force of any one of the cooling influences taken singly, but gives the sum of them all acting simultaneously." The facts illustrated by the heated thermometer are at least six in number, according to the experiments hitherto performed by Dr. Osborne. It shows the conducting power of air and water; the cooling effects of currents of air and water; the effect of wind in cooling the body and all other objects of a higher temperature than itself; the refrigerating effect of air admitted into apartments; the degree of heat derived from fires in rooms as compared with the cooling effect of currents rushing towards the fire; and the cold and heat of climates as actually felt by human beings. It is evident that a heated thermometer is capable of many useful applications.

Re-introduction of Montgolfier Balloons.—The recent scientific ascents that have been made by Mr. Glaisher and Mr. Coxwell, appear to have given a new impulse to ærostation and to have removed it from the class of merely hazardous amusements to the domain of science. In connection with these ascents we may notice the re-introduction of Montgolfier or heated air balloons. It has long been the opinion of many scientific men, that fire balloons are safer and much more easily managed than such as are inflated either with pure hydrogen or the coal gas which is now employed as a substitute. The prejudice against their employment has arisen from the supposed danger of the balloon taking fire from the burning materials employed in rarefying the air, but this danger seems very much overrated; as far as we are aware, no accident from fire ever occurred to a simple fire balloon. One fatal case occurred in France, in which two balloons were employed, the upper filled with hydrogen, the lower with heated air, but the evil result of this manifestly absurd arrangement does not militate against the employment of the simple Montgolfier balloon. M. Godard, an æronaut attached to the French army, has recently ascended from the Pré Catalan in a Montgolfier balloon having a capacity of 4000 cubic metres, which can be inflated in less than half an hour; the fuel used for the purpose being compressed cakes of rye straw. On the last occasion he made a successful descent near Maisons, having performed the journey in twenty six minutes.

Horne and Thornthwaite's Equatorial Stand.—We have examined the equatorial stand produced by the above-named opticians in answer to the demand made by the possessors of moderate-sized telescopes—a demand which we have reason to know has been much increased by the aid afforded to private observers through the succession of astronomical papers in our own pages—and we consider it an excellent instrument for the purpose, and at the price. It consists of a firm pyramidal stand of cast-iron resting upon three bearing-screws, by which, with the aid of the usual spirit-levels, the requisite adjustment can be made. The declination and hour circles are six inches in diameter, and by means of verniers can be read off with all the nicety that any ordinary observer can possibly require. The polar axis is easily inclined to the angle needed by the latitude of the place, and provision is made for fixing the telescope firmly, and securing it precisely at right angles to the axis on which its vertical movements are made. The motions are all smooth and steady, and the workmanship very good.